2022 Chittenden County All Hazards Multi-Jurisdictional Hazard Mitigation Plan

Prepared for Chittenden County, VT

DRAFT Plan – September 15. 2022

Department of Public Safety
Vermont Emergency Management

CHITTENDEN COUNTY RPC
Communities Planning Together

IEM.

Executive Overview

The 2022 Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan (MJAHMP) outlines the strategy adopted by the Chittenden County Regional Planning Commission (CCRPC) and participating municipalities for implementing mitigation practices, improvements, and programs to lessen adverse impacts from natural and man-made hazard events.

At the outset of the hazard mitigation planning process, the Chittenden County All-Hazards Mitigation Plan Update Committee (AHMPUC), active in developing and maintaining previous plans, was reconvened. This Committee was composed of Jurisdictional staff, CCRPC staff, and other key stakeholders, whose task was to prepare a plan pursuant to the federal Disaster Mitigation Act of 2000 (DMA2000). This 2022 plan outlines the method used by the AHMPUC to address the following for each hazard of concern identified during the planning process as having the potential to impact the local population, the built environment, and the natural environment:

- Develop a complete hazard profile.
- Describe the extent of the risks posed by the hazard.
- Discuss each jurisdiction's vulnerability to each hazard.
- Create mitigation strategies (mitigation actions) to be implemented by each jurisdiction to mitigate or reduce the hazard's impact.
- Update the Chittenden County MJAHMP.

The 2022 MJAHMP is a comprehensive update to the current 2017 Chittenden County MJAHMP. Since 2017, municipalities in the County have significantly improved community resiliency as a result of implementing mitigation programs and activities implemented by the various jurisdictional departments, agencies, and stakeholders. The goals and objectives outlined in the 2017 plan were refined in 2022 to reflect changes in community priorities, and to enhance integration among community planning mechanisms. The vision of the 2022 plan is aligned with the Chittenden County Regional Planning Commission's 2018 ECOS Plan mission – encompassing **E**nvironment, **C**ommunity, **O**pportunity, and **S**ustainability concerns -- and is aligned with priorities outlined in the Vermont Emergency Management 2018 State Hazard Mitigation plan.

The 2022 MJAHMP discusses nine primary natural hazards of concern and other technological and societal hazards. Discussion of hazards includes the adverse consequences resulting from a hazard occurrence, as well as information about the impacts of climate change. The risk and vulnerability assessments for all natural hazards were updated using the best available data and a more robust risk assessment platform.

Significant revisions and enhancements were made to the action plan, including the identification of implementation of parameters designed to enhance transparency and promote accountability.

Who Participated in the Planning Process?

The MJAHMP update is a result of a collaborative effort between 18 of the 19 municipalities, residents, the private sector, and regional and state organizations. (The Town of Colchester is not a participant in the 2022 MJAHMP update, as it elected to develop its own mitigation plan.)

The planning area of the 2022 MJAHMP includes eighteen municipalities (18) in Chittenden County.

Table 1.1: 2022 Chittenden County MJAHMP Participating Municipalities

Participating Municipalities	
1	Town of Bolton
2	Buels Gore
3	City of Burlington
4	Town of Charlotte
5	Town of Essex
6	Village of Essex Junction
7	Town of Hinesburg
8	Town of Huntington
9	Town of Jericho
10	Town of Milton
11	Town of Richmond
12	Town of St. George
13	Town Shelburne
14	City of South Burlington
15	Town of Underhill
16	Town of Westford
17	Town of Williston
18	City of Winooski

Public and stakeholder participation and feedback were critical input needed to develop goals and mitigation action items that will be implemented by the person, position, department, or agency whose technical expertise qualifies them as the best entity to be responsible for implementing each mitigation action.

Approach to Plan Development

MJAHMP development encompassed broad participation from a cross-section of stakeholders. This strategy was designed to foster development of a plan that produced specific initiatives that would enable the participating municipalities to reduce the adverse impacts from natural hazards in the county and municipalities through actions embraced by both elected officials and the citizens of the county. The planning process was accomplished in eight phases:

Table 1.2. Phases of the 2022 Chittenden County MJAHMP Planning Process

Phase	Activity
Phase 1	Organize resources and review the prior plan.
Phase 2	Update the hazard identification and risk assessment.

Phase	Activity
Phase 3	Review and update the plan mitigation strategy.
Phase 4	Review and update the plan maintenance strategy.
Phase 5	Assemble the updated plan.
Phase 6	Initiate and complete plan review and adoption.
Phase 7	Implement the approved, adopted plan.

Concurrent with plan development, the municipalities assessed natural hazard risks for Critical Facilities located therein and classified them using the designations identified in the recently released FEMA-designated Community Lifeline categories. Results of this assessment are incorporated into the plan document as appropriate.

Updating the Risk Assessment

Risk assessment is the process of measuring the potential loss of life, personal injury, economic impact, and property damage resulting from natural hazards. The risk assessment was used to rank risk and gauge the potential impacts of each hazard of concern to each jurisdiction. Based on the risk assessment, hazards of concern were ranked for the risk they pose to the overall planning area.

Table 1.3. 2022 Chittenden Summary of Jurisdictional Ranking by Hazard

Jurisdiction	CCRPC	Bolton	Buels Gore	Burlington	Charlotte	Colchester	Essex	Essex Junction	Hinesburg	Huntington	Jericho	Milton	Richmond	St. George	Shelburne	South Burlington	Underhill	Westford	Williston	Winooski
Natural Hazards																				
Dam/Levee Failure	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Flooding	M	H	L	M	M	M	M	M	M	M	M	M	H	L	M	L	H	M	M	L
Fluvial Erosion	M	H	M	M	M	M	M	M	M	M	M	M	H	L	-	-	-	-	L	L
Human Infectious Disease	H	M	L	M	L	M	M	M	M	M	L	M	M	M	M	M	M	M	M	M
Invasive Species	M	M	L	L	M	M	M	L	M	L	L	L	L	L	L	L	L	L	L	L
Severe Rainstorm	H	H	M	H	M	M	M	M	H	M	M	H	L	H	H	H	H	M	H	H
Severe Winter Storm	H	H	H	H	H	H	H	H	H	H	H	H	H	H	M	M	H	H	H	H
Wildfire	L	M	L	L	L	L	L	L	L	L	L	L	L	M	M	L	M	L	L	L

Jurisdiction	CCRPC	Bolton	Buels Gore	Burlington	Charlotte	Colchester	Essex	Essex Junction	Hinesburg	Huntington	Jericho	Milton	Richmond	St. George	Shelburne	South Burlington	Underhill	Westford	Williston	Winooski
Technological Hazards																				
Hazardous Materials	M	L	L	H	L	L	M	M	L	L	L	M	L	L	M	M	L	L	H	M
Major Transportation Incident	M	M	M	M	M	M	M	M	L	L	L	M	H	L	M	M	L	L	M	M
Multi-Structural Fire	M	L	L	H	M	L	M	M	M	M	L	M	L	M	M	M	M	L	M	M
Natural Gas Service Loss	L	L	L	L	L	L	L	L	L	M	L	L	L	L	M	L	L	L	L	L
Other Fuel Service Loss	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L
Power Service Loss	M	H	L	L	M	M	M	M	M	M	M	M	M	H	L	L	H	L	L	H
Sewer Service Loss	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	M	L	L	M	M
Telecommunications Failure	L	M	L	L	M	L	M	M	M	M	M	L	L	L	M	L	L	M	M	L
Water Pollution (algal bloom, etc.)	H	L	L	M	M	L	M	M	L	L	L	L	L	L	M	M	L	L	L	L
Water Supply Loss	M	L	L	L	L	L	M	M	L	L	L	L	L	M	M	M	M	L	L	L
Societal Hazards																				
Civil Disturbance	M	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Crime	M	L	L	L	M	M	L	L	L	L	L	M	M	M	L	L	L	M	M	M
Economic Recession	M	L	L	L	M	M	M	M	M	M	M	M	M	L	M	M	M	M	L	M
Key Employer Loss	L	M	L	L	L	L	M	M	L	L	L	M	M	L	L	L	L	L	L	M
Terrorism	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	M	L	L	L	L

Estimates of the Cost of Potential Damage

Data research and scenario development determined that the costliest type of hazard event in terms of dollar losses would relate to Flooding, which could result in estimated damages of $24 billion in a worst-case scenario.

Develop and Implement a Public Engagement Strategy

The AHMPUC developed a public engagement strategy based on a review of best practices, interviews with community members, and input from technical experts contracted to assist with development of the equity lens a deliberately inclusive element of organizational decision making for the planning process and for generating mitigation action outcomes. The implemented mitigation strategy will promote cooperation between each jurisdiction's government and community organizations. The planning process encouraged public participation during plan development and identifies how the AHMPUC will facilitate continued engagement with residents after the plan is adopted.

The public engagement strategy during the planning process included the following efforts, in addition to publicizing Planning Committee meetings and advising the public that they are welcome to attend these sessions.

- The Planning Committee published on *Front Porch Forum*, Chittenden County community website, a public survey designed to secure public input about hazards that have affected them personally or affected family and friends. The survey generated over 250 responses from community members.
- A Draft Plan was posted on *Front Porch Forum* and on each jurisdiction's website for a 15–30-day public comment period.

Public feedback received throughout the plan update process has been incorporated into the planning document.

Mitigation Strategies and Goals

Regional Strategies from the 2018 CCRPC *ECOS* Plan have been revised for the 2022 MJAHMP update and will guide the plan implementation activities over the next five years:

Table 1.4. 2022 Chittenden County MJAHMP Regional Strategies

Category	Strategy
Category A	Assist municipalities with development of plans, policies, and zoning regulations
Category B	Promote municipal participation in development and implementation of Tactical Basin Plans.
Category C	Assist municipalities to develop & improve infrastructure.
Category D	Assist municipalities in protecting people, buildings, and facilities where development already exists.
Category E	Assist municipalities in promoting growth in appropriate locations and with transportation infrastructure planning.
Category F	Assist municipalities in meeting standards to minimize the required municipal share towards FEMA Public Assistance project costs.

The AHMPUC reviewed and updated the goals from the 2017 MJAHMP and developed a set of supporting objectives. The goals were selected to support the vision and mission identified in each jurisdiction's Comprehensive Plan.

Table 1.5. 2022 Chittenden County MJAHMP Goals

GOAL	ACTIVITY
GOAL 1	Protect existing and planned municipal infrastructure.
GOAL 2	Protect life and residential and business properties from natural and manmade hazards.
GOAL 3	Promote and enhance opportunities for public education about hazard mitigation.
GOAL 4	Encourage municipalities to formally incorporate their local All-Hazards mitigation plan into their comprehensive plan, as well as incorporate proposed mitigation actions into various bylaws, regulations and ordinances, and municipal operating and capital improvement plans.
GOAL 5	Promote appropriate planning for growth with a focus on changing climate and resiliency.

Recommended Actions

The MJAHMP's action plan will present a number of mitigation initiatives designed to reduce or minimize losses from hazard events. Each municipality selected mitigation actions after reviewing a variety of resources, including a mitigation best practices catalog; AHMPUC and other stakeholder recommendations; the results of the risk assessment; and identified issues; public input; other plans and programs; the results of the capability assessment; and actions identified in the 2017 MJAHMP.

Action Evaluation and Prioritization

In developing and prioritizing the 2022 mitigation actions, the AHMPUC elected to use the FEMA recommended Social, Technical, Administrative, Political, Legal, Economic and Environmental (STAPLEE) evaluation criteria tool as outlined in the *FEMA Local Mitigation Planning Handbook* (March 2013). As part of the mitigation strategy, details for each action included the lead agency or position responsible for implementing each action, and a timeline for completion. A qualitative benefit/cost review was also conducted.

Initiate and Complete Plan Review and Adoption

A draft copy of the MJAHMP will be submitted to VEM and FEMA Region I for review and approval. The approved final MJAHMP will be presented to, and adopted by, each municipality's governing body.

Implement the Approved, Adopted Plan

The MJAHMP includes a set of planning worksheets designed to guide the plan implementation process. This phase was designed by, and requires commitment from, each jurisdiction's agencies, elected officials, stakeholders, and county residents to reach each jurisdiction's goal of natural hazard risk reduction.

Continued Public Involvement

The Chittenden County RPC and participating municipalities are dedicated to involving the public directly in the continual review and updates of the MJAHMP. Copies of the Plan will be catalogued and made available at municipal offices. Public comments related to the Plan will be kept with each Jurisdiction's Administrative Office. In addition, copies of the Plan and any proposed changes will be posted on each jurisdiction's website. This site will also contain an email address and phone number of jurisdictional contacts to which comments, recommendations, and concerns can be directed.

Table of Contents

Annexes

Appendices

SECTION 1 INTRODUCTION

What is Hazard Mitigation?

Mitigation is commonly defined as sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects. Hazard mitigation focuses attention and resources on community policies and actions that will produce successive benefits over time. A mitigation plan states the aspirations and specific courses of action that a community intends to follow to reduce vulnerability and exposure to future hazard events. These plans are formulated through a systematic process centered on the participation of individuals, businesses, public officials, and other community stakeholders.

A local hazard mitigation plan is the physical representation of a jurisdiction's commitment to reduce risks from natural hazards. Local officials can refer to the plan in their day-to-day activities and in decisions regarding regulations and ordinances, granting permits, and in funding capital improvements and other community initiatives. Additionally, local plans serve as the basis for states to prioritize future grant funding as it becomes available.

*The **2022 Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan** will be a useful tool for all community stakeholders because it increases public awareness about local hazards and risks, while providing information about options and resources available to reduce those risks. Teaching the public about potential hazards will help each of the municipalities in the planning area protect itself against the effects of hazards and will enable informed decision making on where to live, purchase property, or locate businesses.*

To reduce the nation's mounting natural disaster losses, the United States Congress passed the Disaster Mitigation Act of 2000 (DMA 2000) to amend the Robert T. Stafford Disaster Relief and Emergency Assistance Act. Section 322 of DMA 2000 emphasizes the need for state and local government entities to closely coordinate mitigation planning activities and makes the development of a hazard mitigation plan a specific eligibility requirement for any local government applying for federal mitigation grant funds. These include the Hazard Mitigation

Grant Program (HMGP) and the Building Resilient Infrastructure and Communities (BRIC) program (formerly known as the Pre-Disaster Mitigation (PDM) program), administered by the Federal Emergency Management Agency (FEMA) under the Department of Homeland Security. Communities with an adopted and federally approved hazard mitigation plan thereby become pre-positioned to receive available mitigation funds before and after the next disaster strikes.

The Flood Insurance Reform Act of 2004 (P.L. 108-264) created two grant programs, Severe Repetitive Loss (SRL) and Repetitive Flood Claim (RFC) for National Flood Insurance Program (NFIP) policyholders living in a community covered by a Local Hazard Mitigation Plan (LHMP).

In July 2012, the U.S. Congress passed the Biggert-Waters Flood Insurance Reform Act of 2012 (BW-12), which calls for FEMA and other agencies to make a number of changes to how the NFIP is managed. Key provisions of the legislation required the NFIP to raise premium rates to reflect actual flood risk; make the program more financially stable by assigning premiums on a property's fair market value; and change how Flood Insurance Rate Map (FIRM) updates impact policyholders.

In April 2021, FEMA updated the NFIP's pricing methodology to communicate flood risk more clearly, so policyholders can make more informed decisions on the purchase of adequate insurance and on mitigation actions to protect against the perils of flooding.

Additionally, adoption of a FEMA-approved HMP is a prerequisite for receiving a favorable amount of matching funds from the State of Vermont under its Emergency Relief and Assistance Fund (ERAF) in the event of a FEMA Disaster Declaration.

The ***2022 Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan*** *(*MJAHMP*)* was prepared with significant support from the Chittenden County Regional Planning Commission (CCRPC) and in coordination with the offices of FEMA Region 1 and Vermont Emergency Management (VEM) to ensure the plan meets all applicable DMA 2000 and state requirements. Although the MJAHMP is a multi-jurisdictional plan with a regional approach -- in that it includes eighteen municipalities within Chittenden County and the CCRPC -- it follows the Local Hazard Mitigation Plan (LHMP) criteria defined in the DMA 2000 and the implementing regulation, Title 44 Code of Federal Regulations (CFR), Part 201.6. The LHMP Plan Review Tool, found in **Appendix A**, provides a summary of the federal minimum planning standards and notes the location in this plan where each requirement is met.

Plan Overview

Local hazard mitigation planning is the process of organizing community resources, identifying and assessing hazard risks, and determining how to best minimize or manage those risks. This results in a hazard mitigation plan that identifies specific mitigation actions designed to achieve both short-term planning objectives and a long-term risk reduction. To ensure the functionality of

The ***2022 CC MJAHMP*** *is an* ***all-hazards plan****. While the federal DMA 2000 requires that state, local, tribal, and territorial hazard mitigation plans address only* ***natural*** *hazards, the* MJAHMP *planning team determined that this update should exceed the minimum requirements and include non-natural hazards as appropriate. Thus, the structure of the plan, includes discussion of* ***technological and societal*** *hazards*.

each mitigation action, responsibility is assigned to a specific individual, department, or agency, along with a schedule for its implementation. Plan maintenance procedures are established for routine monitoring of implementation progress, as well as evaluating and enhancing the mitigation plan itself. These plan maintenance procedures ensure the plan remains a current, dynamic, and effective planning document over time.

Typically, mitigation planning is described as having the potential to produce long-term and recurring benefits by breaking the repetitive cycle of disaster loss. A core assumption of hazard mitigation is that pre-disaster investments will significantly reduce the demand for post-disaster assistance by lessening the need for emergency response, repair, recovery, and reconstruction. Furthermore, mitigation practices enable individuals, businesses, and industries to re-establish themselves in the wake of a disaster, getting the community economy back on track sooner and with less interruption.

The benefits of mitigation planning go beyond solely reducing hazard vulnerability. Measures such as the acquisition or regulation of land located in known hazard areas can help achieve multiple community goals, such as preserving open space, maintaining environmental health, and enhancing recreational opportunities. Thus, it is important that the LHMP planning process be integrated with other concurrent local planning efforts, and any proposed mitigation strategies consider other existing community goals or initiatives that will either complement or hinder plan implementation.

Background

Natural hazards are an inevitable part of the world around us. While there is little we can do to control their force and intensity, many actions can be taken to lessen their potential impacts on our communities. The effective reduction of a hazard's impact can decrease the likelihood that such events will result in a disaster. The concept and practice of reducing risks to people and property from known hazards is generally referred to as hazard mitigation.

Hazard mitigation techniques include structural measures, such as strengthening or protecting buildings and infrastructure from the destructive forces of potential hazards; and non-structural measures, such as the adoption of sound land-use policies or creating public awareness programs. Some of the most effective mitigation measures are implemented at the local government level, where decisions are made on the regulation and control of development.

A comprehensive mitigation strategy addresses hazard vulnerabilities that exist today and may exist or be heightened in the foreseeable future. As such, it is essential that projected patterns of development are evaluated in terms of how that growth will increase or decrease a community's overall hazard vulnerability. Land use is a particularly important topic in Chittenden County, where once isolated communities are facing increased rates of growth and redevelopment. Now is the time to effectively guide development away from identified hazard areas and environmentally sensitive locations before unsound development patterns emerge that place people and property in harm's way.

Chittenden County is vulnerable to a range of natural hazards, including flooding; severe winter weather, including, but not limited to: winter storms, winter weather, heavy snow, and ice storms; extreme temperatures; wildfire; and severe rainstorms and high winds, including thunderstorms, high winds, hail, lightning, tornadoes, and tropical storms. These hazards threaten the safety of residents and may damage or destroy both public and private property, disrupt the local economy, and impact the overall quality of life of those who live, work, and visit the region.

One of the most effective ways a community can reduce hazard vulnerability is to develop, adopt, and maintain a LHMP. A LHMP establishes the broad community vision and guiding principles for addressing hazard risk, including the development of specific mitigation actions designed to eliminate or reduce identified vulnerabilities. The ***2022 MJAHMP*** (or "the Plan") is a logical first step toward incorporating hazard mitigation principles and practices into routine activities and functions of local government entities and planning partners in Chittenden County.

The mitigation actions noted in the Plan go beyond recommending structural solutions to reduce existing vulnerability. Local policies addressing community growth, incentives to protect natural resources, and public awareness and outreach campaigns are examples of other measures that can be used to reduce the future hazard vulnerability of Chittenden County. The Plan has been designed to be a living document, with implementation and evaluation procedures included to help achieve meaningful objectives and successful outcomes.

Purpose of the Plan

The purpose of the Plan is to:

- Protect life, safety, and property by reducing the potential for future damages and economic losses that result from All-Hazards.
- Make communities safer places to live, work, and play.
- Qualify for grant funding in both the pre-disaster and post-disaster environment.
- Speed recovery and redevelopment following future disaster events.
- Demonstrate a firm local commitment to hazard mitigation principles; and

- Comply with state and federal requirements for local multi-jurisdictional hazard mitigation plans.

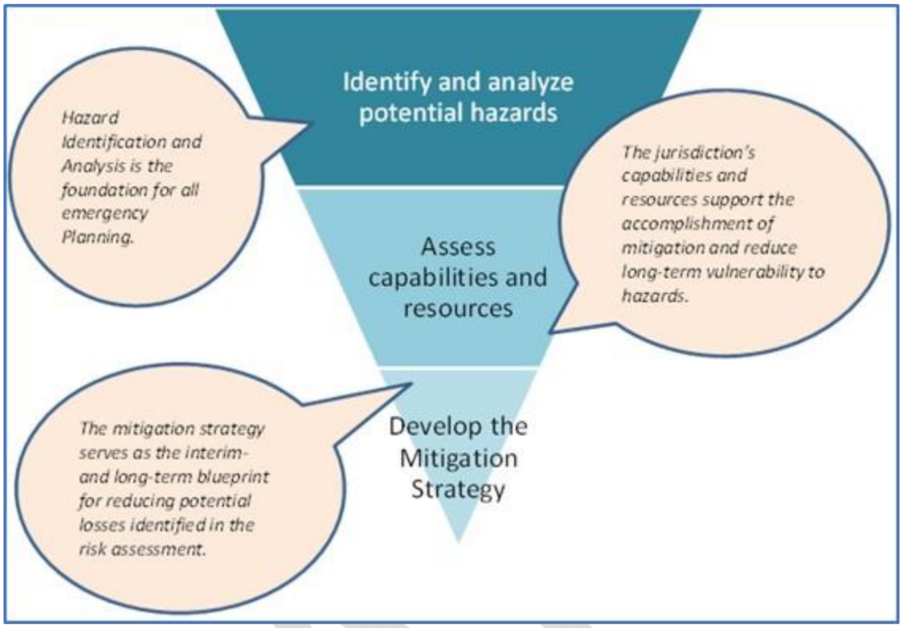


Figure 1-1: Purpose of the *Chittenden County Multi-Jurisdictional All- Hazard Mitigation Plan* Applicability and Scope

This Plan is an update of the *2017 Chittenden County Multi-Jurisdictional All- Hazards Mitigation Plan (*MJAHMP*)*. That plan was developed by the Chittenden County Regional Planning Commission in partnership with its 19 participating municipalities as a dynamic document to guide all-hazards mitigation planning, addressing the most critical natural, technological, and societal hazards. This 2022 Plan is applicable to the geographic areas within the political boundaries of the participating municipalities of Chittenden County, of which all municipalities but the Town of Colchester chose to participate. This update focuses on hazards determined to present the greatest risk to the county overall, and to municipalities in particular.

Specific information about the hazards of concern of each municipality are discussed further in an annex dedicated to discussing the history, needs, and concerns of the municipality in its own dedicated plan section produced with input from local residents and the governing body.

Table 1.1: Municipalities Participating in the 2022 Chittenden County AHMJAHP

Municipality	Annex
Town of Bolton	1

Municipality	Annex
Buels Gore	2
City of Burlington	3
Town of Charlotte	4
Town of Essex	5
Village of Essex Junction	6
Town of Hinesburg	7
Town of Huntington	8
Town of Jericho	9
Town of Milton	10
Town of Richmond	11
Town of Shelburne	12
Town of St. George	13
City of South Burlington	14
Town of Underhill	15
Town of Westford	16
Town of Williston	17
City of Winooski	18

Hazards of concern were determined through a detailed hazard risk assessment and input from local officials and the public. Hazards determined to be of lesser concern were evaluated for their level of risk but were not fully profiled as part of this plan update process. They will be monitored, however, for possible inclusion in a future Plan update. The results of the 2022 risk assessment informed the process of updating and prioritizing mitigation actions based on those hazards which are understood to present the greatest risk to lives and property. There are nineteen municipalities in Chittenden County; however, the Town of Colchester is not participating in the 2022 Update.

Planning process input and feedback included in the plan came from multiple departments, agencies, and organizations within local municipalities, as well as key local, regional, state, and federal stakeholders that provide services and resources or support to Chittenden County. Chief among these is the Chittenden County Regional Planning Commission (CCRPC). This plan also complements, and is consistent with, the *2018 Vermont State Hazard Mitigation Plan (SHMP)*.

Authority and Guidance

This Plan was prepared in compliance with Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (Stafford Act), 42 U.S.C. 5165, as amended by Section 104 of the Disaster Mitigation Act of 2000 (DMA 2000). Local mitigation planning requirements are codified in the Code of Federal Regulations (CFR) Title 44, Section 201.6 (44 CFR §201.6). DMA 2000 specifies requirements for local governments to undertake a risk-based approach to reducing the impacts and consequences from natural hazards through mitigation planning. In addition, DMA 2000 requires that local plans be updated every five years, with each planning cycle requiring a complete review, revision, and approval of the plan at the state and Federal Emergency Management Agency (FEMA) levels.

The plan shall be routinely monitored, evaluated, and revised to maintain compliance with the following provisions, rules, and legislation:

- Section 322, Mitigation Planning, of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as enacted by Section 104 of the Disaster Mitigation Act of 2000 (P.L. 106-390). FEMA's Interim Final Rule published in the Federal Register on February 26, 2002, 44 CFR Part 201.
- The method and schedule for plan maintenance is provided in additional detail in **Section 7 Plan Maintenance,** and a list of additional funding mechanisms are included in **Section 6, Mitigation Strategy.**

Plan Adoption

The Plan, developed in accordance with current state and federal rules and regulations governing local hazard mitigation plans, will be adopted by the Chittenden County Regional Planning Commission and by each participating jurisdiction in accordance with the authority and powers granted to participating municipalities. This point will be reiterated in Section 7 to emphasize its importance.

> *In order to become eligible to receive various forms of Federal hazard mitigation grants, a Chittenden County municipality must formally adopt this Multi-Jurisdictional All-Hazards Mitigation Plan along with that municipality's Local All-Hazards Mitigation Plan Annex, or develop and adopt an independent, stand-alone Local All-Hazards Mitigation Plan.*

Following the designation of the plan as Approvable Pending Adoption (APA) by both Vermont Emergency Management (VEM) and FEMA Region 1, the plan will be brought to each participating jurisdiction for formal adoption by its governing body. Copies of draft local adoption resolutions are provided in **Appendix B.** Final adoption resolutions will be added after adoptions.

Additional information related to plan adoption is provided in **Section 2, Base Plan.**

Summary of Plan Contents

The Chittenden County's updated *MJAHMP* includes seven chapters that address the requirements outlined by FEMA for a complete and effective hazard mitigation plan. Appendices are included in the Plan to provide details and supporting documentation used throughout plan development and provide an efficient process to document the annual evaluation and updates as dictated in the plan maintenance section.

Table 1.2: 2022 Chittenden County MJAHMP Organization

The Base Plan	
Section 1: Introduction	• Provides an overview of hazard mitigation planning and describes the purpose, scope, and framework of the plan.
Section 2: Planning Process	• Explains the methodology used to develop the plan. • Identifies participants on the multi-jurisdictional planning team, convened by the CCRPC known as the All Hazards Mitigation Plan Update Committee (HMPUC). • Summarizes planning and coordination meetings; engagement activities; and public and stakeholder outreach. • Illustrates how existing plans, studies, reports, and technical information were incorporated in and helped to update the plan. • Refers to Appendix C, which includes documentation of the planning process to include materials such as meeting invitations, agendas, minutes, presentations/handouts, sign-in sheets, and copies of outreach materials inviting public participation.
Section 3: Community Profile	• Provides a general description of Chittenden County. • Includes community demographic, geographic, and economic characteristics. • Addresses land use, housing, and critical facilities (Community Lifelines) for the planning area.
Section 4: Hazard Identification and Risk Assessment (HIRA)	• Discusses the HIRA process of identifying hazards to which Chittenden County is prone. • Describes community-identified hazards to be included in this plan. • For each hazard, discusses hazard characteristics, location, extent (or magnitude), previous occurrences, future probability, hazard impact, and the anticipated effects of climate change.
Section 5: Capability Assessment	• Outlines the capabilities of each participating jurisdiction to implement mitigation strategies. • Identifies areas where capability improvements/enhancements may be considered to further advance mitigation strategies. • Provides a status update on each municipalities participation in the National Flood Insurance Program.

The Base Plan	
Section 6: Mitigation Strategy	• Reviews Goals and Objectives of the 2017 *MJAHMP* to determine whether they are still relevant. • Provides a status update on each mitigation action included in the 2017 plan • Describes mitigation successes achieved since 2017 and establishes a systematic approach to achieving updated goals. • Identifies new actions the region overall or each jurisdiction may wish to undertake to further improve resiliency. • Establishes mitigation priorities based on accepted criteria.
Section 7: Plan Maintenance	• Describes the process by which the CCRPC's AHMPUC and other identified officials will ensure the plan is implemented, updated (maintained), and integrated with other local planning initiatives, regulations, and ordinances. • Procedures defined here address how communities will evaluate the effectiveness of this plan by reviewing progress made towards implementation of each mitigation action. • Describes continued engagement of the public and stakeholders in identifying risks that may surface following the development and approval of this plan update.
Jurisdictional Annexes	
Purpose	Jurisdictional annexes provide detailed jurisdiction-specific information on hazard risk and vulnerability, capabilities, mitigation actions, and action plans for implementation that augment information in the Base Plan.
Annex 1	Town of Bolton
Annex 2	Buel's Gore
Annex 3	City of Burlington
Annex 4	Town of Charlotte
Annex 5	Town of Essex
Annex 6	Village of Essex Junction
Annex 7	Town of Hinesburg
Annex 8	Town of Huntington
Annex 9	Town of Jericho
Annex 10	Town of Milton
Annex 11	Town of Richmond
Annex 12	Town of Shelburne

The Base Plan	
Annex 13	Town of St. George
Annex 14	City of South Burlington
Annex 15	Town of Underhill
Annex 16	Town of Westford
Annex 17	Town of Williston
Annex 18	City of Winooski
Appendices	
Appendix A	• Completed FEMA Review Tool
Appendix B	• Copies of Executed or Placeholder Jurisdictional Adoption Resolutions
Appendix C	• Documentation of the Planning Process
Appendix D	• Planning Worksheets
Appendix E	• Public Notification
Appendix F	• Funding Resources

SECTION 2: PLANNING PROCESS

REGULATION: 44 CFR 201.6 Local Mitigation Plans
ELEMENT A. PLANNING PROCESS
§201.6(c)(1) – An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval. **§201.6(c)(2)** – An opportunity for neighboring communities, and local and regional agencies involved in hazard mitigation activities and agencies that have the authority to regulate development as well as businesses, academia, and other private and non-profit other interests to be involved in the planning process. **§201.6(b)(3)** – Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information. **§201.6(c)(1)** – [The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved. **§201.6(c)(4)(i)** – {The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle. **§201.6(c)(4)(iii)** – [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.

Overview of Mitigation Planning Process

This section describes the planning process used to develop/update the *Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan* (MJAHMP), which is a Local Hazard Mitigation Plan (LHMP), as defined by Title 44, C.F.R., §201.6. Information included here outlines the planning process; states who was involved in the process; public engagement efforts; and how the planning committee incorporated elements from existing municipal and county plans and other relevant information into the plan.

Planning Process

IEM was contracted to facilitate the 2022 MJAHMP update in coordination with the Chittenden County Regional Planning Commission (CCRPC) and the Chittenden County AHMPUC. The collaborative process established the framework and methodology for the current planning effort using FEMA's *Local Mitigation Planning Handbook* (March 2013). To ensure that the LHMP met the requirements of the DMA 2000, an approach to the planning process and plan documentation was developed to achieve the following two goals:

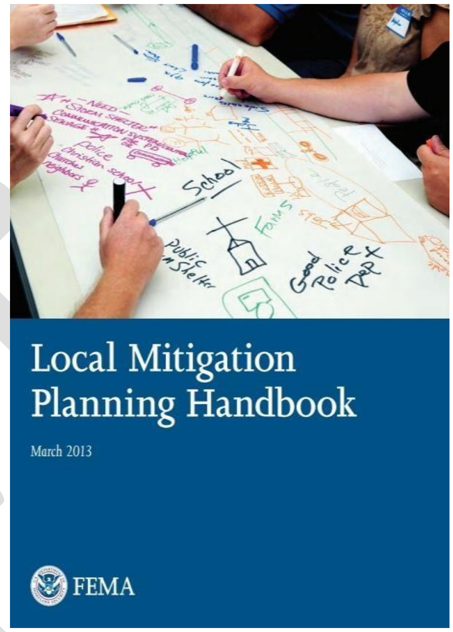


Figure 2.1: FEMA's 2013 Local Mitigation Planning Handbook is a key guidance document for local communities preparing a hazard mitigation plan.

- The AHMPUC considered a broad range of natural, technological, and societal hazards potentially facing the county and its municipalities, thereby satisfying the natural hazards mitigation planning requirements specified in DMA 2000.
- The LHMP planning process was developed in keeping with DMA 2000, FEMA regulations, and FEMA and Vermont Emergency Management (VEM) guidance.
- The AHMPUC consulted with VEMA, and FEMA Region 1 as needed during the planning process so the group could incorporate feedback throughout the planning process and minimize the need for plan revisions when the document was submitted for draft or final review.

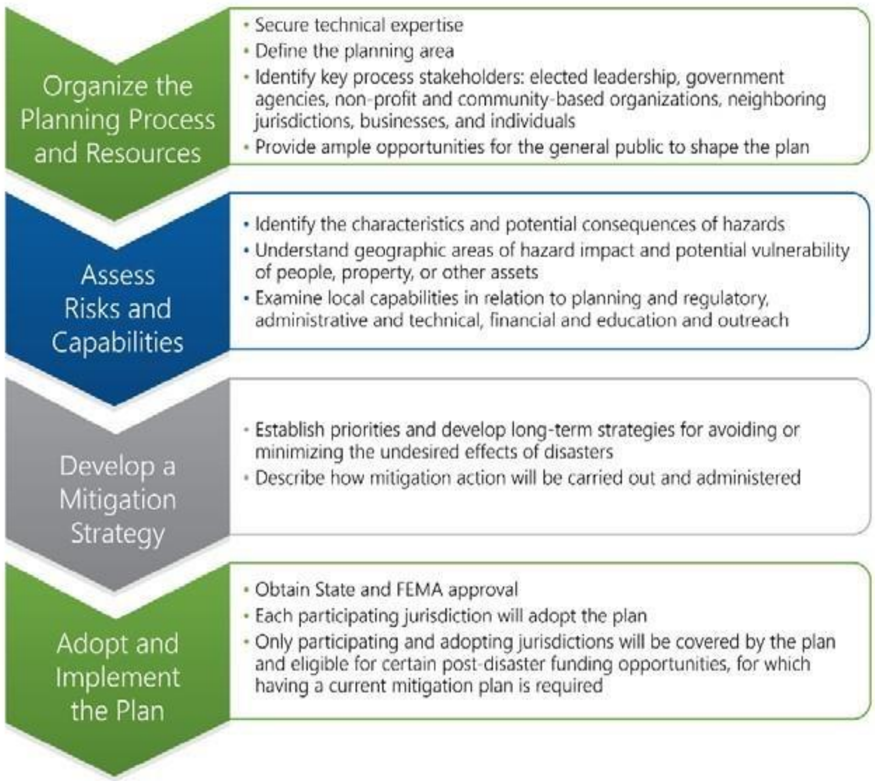


Figure 2.2: *The Chittenden County MJAHMP Planning Process*

This process ensured that all federal and state requirements were met, and the plan would not be found deficient during the state and federal review processes by meeting the current standards and regulations as outlined by FEMA and VEM. As such, Chittenden County and its municipalities will remain eligible for all appropriate benefits under state and federal laws and practices.

Throughout the plan development/update process, a concerted effort was made to gather information from participating municipalities and staff, as well as other local organizations, utilities, federal and state agencies, neighboring municipalities, and the county residents. The AHMPUC solicited information from local agencies and individuals with specific knowledge of certain natural hazards and past historical events, planning and zoning codes, ordinances, and recent planning decisions affecting hazard mitigation planning. The natural hazard mitigation strategies identified in this plan have been developed through an extensive planning process involving municipal agencies, officials, and staff.

All-Hazards Mitigation Plan Update Committee

Through an open bid process, the VEM selected planning consultant IEM to facilitate the plan update process. IEM worked in concert with the Chittenden County Regional Planning Commission to reconvene the CCRPC's All-Hazards Mitigation Plan Update Committee

(AHMPUC). The AHMPUC is made up of representatives from key departments of the eighteen participating municipalities, as well as stakeholder representatives from local and regional agencies and entities that are key to implementing hazard mitigation initiatives. Additionally, each jurisdiction was encouraged to establish a Jurisdictional Planning Team to assist with data collection and implementing jurisdictional hazard mitigation initiatives.

DMA 2000 requires that each jurisdiction participating in the planning process officially adopts the multi-jurisdictional hazard mitigation plan and must participate in the process to develop the plan as discussed at the first planning meeting, and to:

- Designate a representative to serve on the AHMPUC.
- Participate in at least one of the three AHMPUC planning meetings by either direct representation or authorized representation.
- Provide data for and assist in the development of the updated risk assessment that describes how various hazards impact their municipality.
- Provide data to describe current capabilities.
- Develop/update mitigation actions (at least one) specific to each jurisdiction.
- Provide comments on plan drafts as requested.
- Inform the public, local officials, and other interested parties about the planning process and provide opportunities for them to comment on the plan.
- Formally adopt the mitigation plan.

All municipalities in Chittenden County except the Town of Colchester chose to participate in the *2022 MJAHMP* planning process. Sign-in sheets for each meeting are included in **Appendix C: Meeting Documentation**.

Table 2.1: Chittenden County *MJAHMP* All-Hazards Mitigation Plan Update Committee (AHMPUC)

Name	Title	Agency/Organization
Amy Grover	Town Clerk & Treasurer	Town of Bolton
Jake Perkinson	Gore Supervisor	Buel's Gore
Norm Baldwin	City Engineer	City of Burlington
Larry Lewack	Planner	Town of Charlotte
Chief Ron Hoague	Chief of Police	Essex Police Department Also represented the Village of Essex Junction
Todd Odit	Town Administrator	Town of Hinesburg
Darlene Palola	Resident appointed by Town	Town of Huntington
John Abbott	Town Administrator	Town of Jericho
Michaela Foody	Director of Public Safety	Town of Milton
Ravi Ventkataraman	Town Planner	Town of Richmond

Name	Title	Agency/Organization
Neil Boyden	Town Clerk & Treasurer	Town of St. George
Lee Krohn	Town Manager	Town Shelburne
Paul Conner	Director of Planning & Zoning	City of South Burlington
Brad Holden	Town Administrator	Town of Underhill
Kate Lalley	Zoning Administrator	Town of Westford
Matt Boulanger	Planning Director & Zoning Administrator	Town of Williston
John Audy	Fire Chief	City of Winooski

Name	Title	Agency/Organization
Significant Supporting Organizations		
Dan Albrecht	Senior Planner	Chittenden County Regional Planning Commission
Charles Baker	Executive Director	Chittenden County Regional Planning Commission
Pam Brangan	GIS Data and IT Manager	Chittenden County Regional Planning Commission
Garret Mott	CCRPC Board Member	Chittenden County Regional Planning Commission
Caroline Massa	Sr. HMP Planner	Vermont Emergency Management
Leroy Thompson	Project Manager	IEM
Nancy Freeman	Sr. Planner/Planning Lead	IEM
Elizabeth Burnett	Jr. Planner	IEM
Barbara Spaulding	Sr. Planner	IEM

Table 2.2: Chittenden County Municipal Participation Record

unicipality	Invited to Attended Kick-Off Meeting	Participated in Kick-Off Meeting	Participated in Hazard Identification and Risk Assessment Meeting	Participated in Mitigation Strategy Meetings December 12, 2021	Returned Planning Worksheets	Provided Draft Plan for Review	Attended Draft Plan Review Meeting (12/15-16/2021	Provided Additional local and technical data	Adopted Plan
Chittenden County RPC	X	X	X	X	-	X	X	X	
Town of Bolton	X	X	X	X	X	X	X	X	
Buel's Gore	X					X			
City of Burlington	X	X	X	X	X	X	X	X	
Town of Charlotte	X		X	X		X	X		
Town of Essex	X	X	X	X	X	X	X	X	
Town of Essex Junction	X	X	X	X	X	X	X	X	
Town of Hinesburg	X			X	X	X		X	
Town of Huntington	X		X	X	X	X	X	X	
Town of Jericho	X			X		X	X		
Town of Milton	X	X	X	X	X	X	X	X	
Town of Richmond	X		X	X	X	X	X	X	
Town of Shelburne	X					X		X	
City of South Burlington	X	X	X	X	X	X	X	X	
Town of St. George	X					X			
Town of Underhill	X		X	X	X	X	X	X	
Town of Westford	X	X		X	X	X	X	X	

unicipality	Invited to Attended Kick-Off Meeting	Participated in Kick-Off Meeting	Participated in Hazard Identification and Risk Assessment Meeting	Participated in Mitigation Strategy Meetings December 12, 2021	Returned Planning Worksheets	Provided Draft Plan for Review	Attended Draft Plan Review Meeting (12/15-16/2021	Provided Additional local and technical data	Adopted Plan
Town of Williston	X	X	X	X	X	X	X	X	
Town of Winooski	X		X	X	X	X	X	X	

A cross-section of stakeholders and Subject Matter Experts participated at different stages of the plan update process. Their participation included providing information on hazard occurrences or critical facility locations, attending meetings, updating mitigation strategy/actions, and reviewing plan drafts. Due to COVID-19 outbreak, the list of available stakeholders was limited. It is recommended as part of the next plan update that additional effort and outreach be provided to expand the list stakeholders.

Table 2.3: Stakeholder Participation

Agency/Organization	Area of Assistance
NOAA/National Weather Service, Burlington Int'l Airport	Review of hazard profiles and provided additional weather-related data.
Vermont Agency of Natural Resources	Reviewed fluvial erosion profile and provided additional data. Reviewed and provided NFIP related data.
Vermont Department of Forests, Parks and Recreation	Review of hazard profiles and provided additional wildfire related data.

Planning Meetings

During the planning process, the entire state was affected by Coronavirus Disease-2019 (COVID19) from early 2020 to the present. This limited the degree to which in-person meetings could take place between the consultant, jurisdictional staff, and other members of the AHMPUC. As such, extensive outreach was conducted by telephone, e-mail, and Microsoft Teams virtual conference calls. The consulting team aggressively reached out to jurisdictional staff and other stakeholders to secure updated community data and to review the updated plan.

The same communications vehicles were used to conduct AHMPUC meetings. Minutes and copies of the meeting handouts and PowerPoint presentation for each of the meetings are included in Appendix C.

The planning process resulting in the preparation of this plan document officially began with an initial coordination Conference Call/Webinar with the project team on March 15, 2021. After the initial coordination meeting, a formal Kick-off planning virtual Microsoft Teams meeting was held on June 22, 2021, followed by additional planning meetings held on October 13, 2021, December 15 and 16, 2021, and April 5, 2022. In addition, separate meetings were held with individual municipalities upon request to assist with data gathering and completing the planning worksheets. Two Virtual Open Office sessions were held in February 2022 to provide assistance in completing all planning related documents and answer any questions related to the planning process. A complete list of all representatives of the agencies and organizations that participated on the Chittenden County AHMPUC is provided in Appendix C. The AHMPUC team members communicated with each other and with stakeholders and other organizations between full committee meetings through a combination of virtual meetings, phone interviews, and email correspondence.

Table 2.3: Schedule of AHMPUC Meetings

Meeting	Topic	Date
Informational Meeting	General overview of planning process/requirements and schedule.	March 15, 2021
Kick-off Meeting	• Introduction to DMA 2000, the planning process, hazard identification, and public input strategy. • Distribution of data collection guide to municipalities. • Preliminary hazard data discussed, along with required compiled GIS data to develop a critical facility inventory.	6/22/2021
Planning Risk Assessment Meeting #2	• Review of draft Risk Assessment, update plan goals, instructions to update status of previous mitigation actions.	10/13/2021
Planning Mitigation Strategy Meeting #3	• Development of new mitigation actions, mitigation action planning and prioritization. • Determine process to monitor, evaluate, and update plan. • Two meetings held to accommodate attendees.	12/15/2021 12/16/2021
Other Planning Meetings	• Separate meetings were held with individual municipalities that were not able to attend the regular AHMPUC meetings. These conference call meetings consisted of a summary of the information and requirements presented in the regular AHMPUC meetings. • Participated in the June 30, 2021, Chittenden County Emergency Management Director Round Table to discuss and solicit their participation as part of the Hazard Mitigation Planning Team for the update of the 2017 MJAHMP.	Dates Vary

At the **June 22,2021** AHMPUC Kickoff Meeting, IEM outlined the scope and purpose of the plan, participation requirements of AHMPUC members, and the proposed project work plan and schedule. The meeting enabled the group to establish planning process standards and secure jurisdictional input on the best ways to facilitate public involvement and coordination with other agencies and departments. IEM also discussed hazard identification requirements and data needed to develop updated hazard profiles (including potential new hazards), including past occurrences and hazard impacts. Available information about hazards enabled the group to identify hazards of concern for Chittenden County. The hazard ranking methodology utilized in the County's 2017 *MJAHMP* was slightly adjusted, introduced, and preliminary information was presented for each identified hazard of concern.

Each participant received a copy of the IEM *Chittenden County Data Collection Guide* to facilitate the collection of information needed to support the plan, including input on:

- Past hazard occurrences
- Community assets/Community Lifelines
- Affected populations, especially at-risk populations
- The dollar value of potential residential and commercial disaster-related losses, including residential property, the built environment; and the natural environment
- Jurisdictional capabilities and available resources useful for managing ongoing mitigation programs and proposed new mitigation actions.

Each participating jurisdiction returned the completed worksheets in the *Data Collection Guide* to IEM and their input was incorporated into relevant sections of the plan as appropriate.

Hazard Identification and Risk Assessment

The **October 13, 2021,** meeting focused on hazard identification and developing the hazard risk assessment; community vulnerabilities; and community capabilities. AHMPUC members were asked to review if and how each of the identified hazards of concern affected their community, a step that would lend itself to hazard ranking.

The group was also asked to pay special attention to assets that fall into categories described by FEMA as Community Lifeline Components to ensure consideration of the full range of critical facilities and assets that could be potentially at risk to one or more hazards. Meeting participants reviewed the Community Lifeline categories, which include Safety and Security; Food, Water, and Shelter; Health and Medical; Energy (Power and Fuel); Communications; Transportation; and Hazardous Materials.

IEM assisted the AHMPUC in a process of identifying/updating the hazards that have impacted or could impact, communities in Chittenden County. At the Risk Assessment meeting, IEM presented an overview of the list of hazards considered in the *2017 Chittenden County*

MJAHMP and the *2018 Vermont State Hazard Mitigation Plan (SHMP)*. IEM presented an suggested list of recommended hazards for consideration that would be moved forward and included in the 2022 Plan update. This included a discussion of past hazard events, types of hazard-related damage, and where additional information might be found. Further discussion about the hazard identification process and which hazards were identified as being a risk for each jurisdiction is provided in Section 4-Hazard Identification and Risk Assessment.

As part of the hazards and risk vulnerability update, each jurisdiction was provided another copy of the Critical Facilities Worksheet, along with the list of critical facilities assets included in the 2017 Plan and asked to review and update them as needed. Each jurisdiction was encouraged to include additional assets not previously identified, such as historic, cultural, and economic assets, as well as specific vulnerable populations. Data was also obtained from the U.S. Census Bureau and from jurisdictional planning mechanisms, such as Comprehensive Plans and Future Development Plans.

After profiling Chittenden County hazards of concern and critical assets, the AHMPUC collected information to describe the likely impacts of future hazard events on the participating municipalities. For each hazard, the group discussed how future development and climate change may affect assets vulnerable to each hazard.

Considering information identified during risk analysis and vulnerability assessment discussions, additional information was procured by consulting local stakeholders, subject matter experts, and residents using multiple communication efforts to estimate losses for each profiled hazard. For geographic hazards such as river flooding, specific assets/areas at risk and loss estimates were determined through GIS analysis. For other hazards, such as weather-related hazards, loss estimates were developed based on statistical analysis of historic events. For hazards such as dam failure, GIS data was not available to identify specific geographic boundaries at risk. Therefore, the risk assessment provides descriptions of the types of improvements located in approximate risk areas. Stakeholders, including a meteorologist from the Burlington, VT office of the National Weather Service (NWS), also reviewed draft hazard data, provided feedback, and shared additional data resources. The methodologies for each loss estimate are described in detail in Section 4. Within each hazard section, the text provides details on how the hazard varies by jurisdiction, where applicable. Each hazard profile concluded with a summary of the specific location affected; magnitude (or extent); previous occurrences; probability of future occurrences; and jurisdictional risks and vulnerabilities.

Capabilities Assessment

The level of existing mitigation capabilities countywide and by jurisdiction were factored into developing loss estimates. This assessment consisted of identifying the existing mitigation capabilities of participating municipalities about the extent of their current government programs, policies, regulations, ordinances, and plans that mitigate or could be used to mitigate risk from hazards. Participating municipalities provided information on their regulatory, personnel, fiscal, and technical capabilities, as well as previous and ongoing mitigation initiatives. This information is included in the Capabilities Assessment included in **Section 5**. Each participating jurisdiction was provided a copy of local capabilities information included in the 2017 Plan and asked to update the list. Participants were also asked about capabilities in the categories of Safe Growth and Education and Outreach. Specific capabilities such as participation in the National Flood Insurance Program (NFIP), designation as FireWise Communities or StormReady Communities, and placement of warning sirens are incorporated in the vulnerability analysis discussions as appropriate. This information is included in **Section 5 - Mitigation Capabilities**.

Review of 2017 Mitigation Strategy

At the AHMPUC Mitigation Strategy meetings held on **December 15, 2021**, and **December 16, 2021**, IEM facilitated a review and update of elements included in the 2017 *CC MJAHMP*. These included the goals and objectives; previously identified mitigation actions; and key findings from current risk, vulnerabilities, and capabilities assessments. The AHMPUC also considered new mitigation goals, objectives, and mitigation actions proposed to support regionwide and jurisdictional priorities. Common categories of mitigation goals and objectives were presented. The revised/validated goals and objectives for this plan update are provided in **Section 6 – Mitigation Strategy.**

It was the consensus of the AHMPUC that the CCRPC Regional Strategies would be included in Section 6 of the Base Plan to again mesh with the CCRPC's planning processes and work program, both as a regional entity with a significant role in the multi-jurisdictional plan, and as a supportive stakeholder for each participating jurisdiction. The meeting discussion included an explanation of how the proposed goals, description of the methodology for identifying objectives, and mitigation actions were determined by the municipalities.

The group discussed the types of mitigation actions/projects that could be implemented by the municipalities in Chittenden County. Consideration was given to the analysis results provided in the risk assessment and the anticipated success for each project type, along with the level of capabilities for smaller communities. Jurisdictions were encouraged to maintain a focused approach and move forward only those actions that are aimed at implementing long-term solutions to prevent hazard-related losses. Projects relating to emergency response were discussed, but participants were encouraged to focus on enduring solutions since response related mitigation actions occur on a routine basis as requirements of other plans. This opportunity to discuss a broad range of mitigation alternatives allowed the municipalities to understand the overall priorities of the committee and allow for discussion of the types of projects most beneficial to each jurisdiction. As part of this discussion, consideration was given to the potential cost of each project in relation to the anticipated future cost savings by calculating a benefit-cost analysis. The jurisdictions were also provided instructions for reviewing the status of previous actions and completing the Mitigation Action Plan for Implementation for each continuing and newly developed action.

An inclusive and structured process was used to develop and prioritize new mitigation actions for this plan using the criteria outlined in the FEMA *Local Mitigation Planning Guide*. The AHMPUC approved the FEMA recommended STAPLEE criteria for prioritizing all actions for the 2022 *MJAHMP*. The AHMPUC identified proposed actions, costs and benefits, the responsible primary and supporting entities, effects on new and existing buildings, implementation schedules, priorities, and potential funding sources.

Plan Maintenance

The FEMA Review Tool includes criteria under Element A: Planning Process to regularly review the *MJAHMP*.

> *A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating, and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))*

The 2022 *MJAHMP* Base Plan concludes with **Section 7- Plan Maintenance**, which outlines all steps proposed to keep the plan current. This section includes support documents that the CCRPC and municipalities may use in documenting how the plan was monitored, evaluated, and updated during the plan's five-year cycle. In each annex, the municipality has designated a lead position to be responsible for all plan maintenance activities. The Plan Maintenance Schedule identifies the responsible party for initiating each activity required as part of the plan maintenance process.
Another requirement listed under FEMA LHMP Planning Element A: Planning Process, mandates ongoing public involvement in plan maintenance.

> *A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))*

The AHMPUC welcomes community input and feedback at any point during the five-year planning cycle and has incorporated steps in the plan maintenance process to ensure this is carried out. The group will also coordinate with the CCRPC to post regular notices on its website advising stakeholders and the public of mitigation actions in progress, and the most recent steps taken to update the plan and how residents and stakeholders may contribute their input.

Public Engagement

Under FEMA guidelines, the local hazard mitigation planning process must create opportunities for members of the public to be involved in plan development—at a minimum, during the initial drafting stage and during the plan approval stages. At the Kick-off Meeting, the AHMPUC discussed options and means for soliciting public input at different stages.

Due to COVID-19 requirements for social distancing, planned in-person public meetings did not take place during the plan update process. Consequently, the AHMPUC developed a *Virtual Engagement Plan (VEP)* to guide all public engagement activities. To engage the public in the process, a hazard survey was developed and distributed in October 2021 specific to the CC MJAHMP update and provided a brief plan summary as well as a questionnaire to capture public and stakeholder input. A link to the survey was widely distributed through all 19 municipalities of the County via a posting to the electronic neighborhood forum known as Front Porch Forum and reached an estimated 79,000 registered users. Additionally, the CCRPC distributed the survey via email to over 400 municipally affiliated contacts, as well as in hard copy at each jurisdiction administrative building throughout the County. The survey was posted online at www.surveymonkey.com A summary of the results is incorporated into the respective sections of the plan. A copy of the survey is included in **Appendix E.**

Hazard Mitigation Planning for Chittenden County

Hazard mitigation planning is a process that identifies hazards and their risks to your community. Over the next several months, your community's Hazard Mitigation will be updated.

Read below about how to learn more and participate!

This This is your community's plan!

To have value, the plan must represent the current needs and values of your community and be useful for officials, stakeholders, and citizens. Consider the critical importance of mitigation to:

Protect public safety and prevent loss of life and injury.

Lessen impact to existing and future development.

Prevent damage to a community's unique cultural, historical, and environmental assets.

Take the Survey »

Disasters can happen anytime, anywhere, and any place.

- They cause loss of life, damage buildings and infrastructure, and have devastating consequences on a community's economic, social, and environmental well-being.
- Hazard mitigation planning is a process that identifies hazards and their risks to your community and assesses the vulnerability of people, property, the environment, and the economy to one or more hazards. The end result is a comprehensive mitigation strategy that presents recommended sustained actions to reduce disaster-related damages and minimizes long-term community risk to the hazards.
- In June 2021, Chittenden County municipalities initiated a collaborative planning effort to develop the 2022 update of the Chittenden County Multi-Jurisdictional Hazard Mitigation Plan. The benefits derived from the planning process, and the recommended mitigation actions that will ultimately be implemented, will significantly improve community resilience and sustainability.

Over the next several, months staff of **IEM, an international disaster and crisis management firm** will be working with emergency management, planning and public works staff of your local municipality to update your municipality's local Hazard Mitigation Plan

Your knowledge of local hazards is critical to good planning.
Participate in our online survey!

Take the survey to provide your opinion on local hazard events and their impact on you, your family, and the community. The survey will be open from October 1 through October 30.
Contact your local city or town officials to learn how to provide comment on the draft municipal Local Hazard Mitigation Plan to ensure it reflects your experience and concerns

Questions & Contact

If you have questions, contact Dan Albrecht, CCRPC Senior Planner at dalbrecht@ccrpcvt.org or 802-861-0133

or

Leroy Thompson, IEM Senior Planner at leroy.thompson@ieminc.com or 850-570-9867

More Information

*To view the current mitigation plan for your community please visit the **CCRPC website**.*

This planning project is funded by a FEMA grant provided through Vermont Emergency Management (VEM). The project is a joint effort between IEM and the Chittenden County Regional Planning Commission (CCRPC) to assist Chittenden County municipalities.

Figure 2.3: Chittenden County Public Survey Announcement, Chittenden County Regional Planning Commission Website

The survey included a question about community assets the residents perceive as being the most vulnerable to the effects of natural hazards. Collective survey findings show residents who self-identified as living and/or working in all municipalities participated in the survey. Respondents stated that natural hazards primarily affecting them, or someone in the household, include extreme temperatures, invasive species, severe rainstorms, and severe winter storms. Technological hazards about which respondents are most concerned include loss of power and telecommunications failure. Societal hazards about which residents are most concerned include economic recession, crime, and key employer loss. Participants showed a high level of concern for hazards resulting in loss or injury to human life; economic loss; the ability of communities to govern; damage to infrastructure, including loss of bridges, utilities, schools, hospitals, and healthcare centers; and other critical assets.

A Press Release was developed and released on March 24, 2022, notifying the public that the Draft 2022 Chittenden County *MJAHMP* is available for public review and comments. The draft Plan was posted to the electronic neighborhood [Front Porch Forum] for public review. A copy of the press release and notice is provided in **Appendix E**.

Outreach to Neighboring Municipalities

During the planning process, the consultant coordinated with the CCRPC and local municipalities to identify neighboring jurisdictions with a potential interest in the plan update. Notice was sent to the following neighboring municipalities inviting them to review the draft Chittenden County AHMJP and submit comments to Leroy Thompson with IEM. No comments on Plan were received back from the neighboring communities.

Table 2.4: Neighboring Jurisdictions Contiguous to Chittenden County Municipalities

Municipalities	Contact	Contact Information	Date Notice Provided
Addison County			
Town of Ferrisburgh	Town Clerk's Office	townclerk@ferrisburgvt.org	March 24, 2022
Town of Monkton	Town Clerk Office	townclerk@monktonvt.com	March 24, 2022
Town of Starksboro	Town Clerk Office	amy@starksborovt.org	March 24, 2022
Franklin County			
Town of Fairfax	Town Clerk Office	clerk@fairfax-vt.gov	March 24, 2022
Town of Georgia	Town Administrator Office	administrator@townofgeorgia.com	March 24, 2022
Lamoille County			

Municipalities	Contact	Contact Information	Date Notice Provided
Town of Cambridge	Town Administrator Office	townadministrator@cambridgevt.org	March 24, 2022
Town of Stowe	Town Administrator Office	csafford@stowevt.org	March 24, 2022
Washington County			
Town of Duxbury	Town Clerk Office	dux.townclerk@gmail.com	March 24, 2022
Town of Waterbury	Municipal Manager	wshepluk@waterburyvt.com	March 24, 2022
Town of Fayston	Town Clerk	plewis@faystonvt.com	March 24, 2022

Figure 2.5: Neighboring Municipalities to Chittenden County, VT.[1]

Draft Plan Review

The AHMPUC was provided a copy of the draft of the 2022 MJAHMP Update for review and input on February 23, 2022. The draft MJAHMP was then presented to the Chittenden County RPC Board meeting on March 16, 2022. After group feedback was incorporated into the draft plan, it was posted for review on the CCRPC web site for the public comment period from March 21 to April 4, 2022, and widely promoted through RPC and jurisdictional communications tools. This allowed the AHMPUC to receive feedback from stakeholders and the public. Unfortunately, throughout the initial long period during which the impact of COVID-19 was ongoing, many jurisdictional buildings were closed or included limited access. This limited the ability of residents to visit administrative centers to review hard copies of the document in person. The jurisdictions distributed notifications about the public review draft through social media accounts and other online sources. The City of Burlington and Towns of Bolton, Essex, Essex Junction, and City of South Burlington and the CCRPC provided feedback and comments on the draft plan document. All feedback was considered and incorporated as appropriate into the final Draft Plan submitted to VEM for its review and feedback.

Plan Revision and Adoption [Pending final information]

IEM incorporated all feedback and comments from the AHMPUC, stakeholders, neighboring municipalities, the public, and other interested parties into the review draft plan. IEM then resubmitted the plan on XXXX, 2022 to VEM to begin the formal State/FEMA review process. IEM made additional revisions to incorporate comments from VEM and FEMA as appropriate and resubmitted the plan to VEM and FEMA for final approval. The Board of the Chittenden County RPC formally endorsed the plan at its Month Day, 2022 meeting.

Upon approval, VEM will provide the CCRPC and participating municipalities copies of formal letter from VEM/FEMA Region 1 stating that all required elements of the formal FEMA

[1] Map retrieved at: www.familysearch.org

Mitigation Planning Process have been duly satisfied. The governing body of each of the 18 participating municipalities then considered passing an adoption resolution formalizing its acceptance of the plan. A draft copy of the Adoption Resolution is included in Appendix B, and final Adoption Resolutions are included in each jurisdiction annex.

Plan Resources

IEM, with the assistance of the CCRPC, consulted a range of plans, studies, technical reports, datasets, and other resources to prepare the hazard assessment, develop maps, conduct the vulnerability analysis, and other components of this Plan. Some of these documents, including FEMA resources, provided information on risk, existing mitigation actions currently underway, and ideas for possible future mitigation actions. Other resources, including those from NOAA, provided histories of disasters in the area. United States Army Corps of Engineers (USACE) data was reviewed for the assessment of the risk to dam/levee failure and potential projects in the region. Materials from FEMA and VEM were reviewed for guidance on plan development requirements. The CCRPC and each of the participating municipalities included actions from other plans, such as Floodplain Management Plans and Stormwater Management Plans, as examples of how identified mitigation actions may be implemented and incorporated into other planning mechanisms. Previous hazard events, occurrences, and descriptions were identified using NOAA's National Centers for Environmental Information (NCEI) Storm Events Database, the results of which are included in multiple sections of this Plan. Key resources consulted are presented here and in each of the Plan sections.

Integration of Other Data, Reports, Studies, and Plans

Input was secured from many other agencies and organizations that provided information but were not able to attend planning meetings. In an effort to incorporate their resources into the plan, the AHMPUC collected and reviewed existing technical data, reports, and plans, including:

- *Vermont State Hazard Mitigation Plan (September 2018)*
- *Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan (March 2017)*
- *Chittenden County Regional Plan* also known as the *"ECOS" Plan*
- National Flood Insurance Program Policy and Loss Statistics
- Flood Insurance Administration, Repetitive/Severe Repetitive Loss Property Data
- Flood Insurance Rate Maps for all of Chittenden County
- National Oceanic and Atmospheric Agency (NOAA), National Centers for Environmental Information (NCEI) – Storm Events Database
- National Inventory of Dams and Vermont Dam Inventory
- National Risk Index
- Centers for Disease Control and Prevention (CDC), Social Vulnerability Index

- Various local plans such as Comprehensive Plans, Economic Development Plans, Capital Improvement Plans, etc.

These and other sources of information referenced within the footnotes in this Plan were used in the development of the hazard identification, vulnerability assessment, and capability assessment and in the formation of goals, objectives, and mitigation actions.

Table 2.4: Key Resources Consulted for Plan Development

Key Resources	Example Uses
• *2017 Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan*	• Background information about local hazards.
• *2018 Vermont State Hazard Mitigation Plan*	• Identification of State hazards of concern, risks/ vulnerabilities, and mitigation strategies.
• Chittenden County Regional Planning Commission reports and documents: annual work plan, ECOS Plan for environmental sustainability; and others	• Review of current community planning efforts and ways the 2022 update can be integrated into same.
• Chittenden County Hazard Mitigation Planning Data Collection Guide	• IEM tool completed by each jurisdiction to provide input on jurisdictional hazards, community assets, vulnerabilities, capabilities, actions, priorities, and plan implementation.
• NOAA, NCEI, National Storm Events Database	• Historical data of events from 1950 to June 30, 2021, with a focus on events occurring since the 2017 MJAHMP was adopted, including input from subject matter experts and previous lessons learned.

Key Resources	Example Uses
• U.S. Federal Emergency Management Agency (FEMA)	• Planning and program guidance, including funding information about programs related to HMA, FMA, BRIC, and Community Lifelines. • Use of the FEMA Review Tool on which to base plan sections and ensure the plan adheres to 44 CFR Part 201.6 requirements.
• Vermont Emergency Management (VEM)	• Planning guidance and feedback, information about statewide hazard conditions and development trends.

• FEMA	• Definition of hazard mitigation. • References to federal and state Governing Authorities and Guidance, such as DMA 2000.
• FEMA	• Review Tool served as basis for discussing Planning Process per CFR requirements. • Federally Declared Disasters for Vermont and Chittenden County. • Data Visualization Page output for Chittenden County.
• National Risk Index for Natural Hazards • University of Vermont Climate Change Assessment • Centers for Disease Control and Prevention • National Risk Index	• • Regional Vulnerability by Hazard Type Natural Hazards and Climate Change Social Vulnerability Index Risk comparison for Chittenden County, Vermont, and the United States.
• Vermont Dam Inventory • USACE National Inventory of Dams	• Information about dams located in Chittenden County and whether they are ranked as being of low, moderate, high, or significant community hazard risk.
• • United States Census Bureau Additional Information was collected from multiple sources within each jurisdiction.	• Identified local demographics, geography, governance, vulnerable populations, built environment (including community assets, Community Lifelines, and infrastructure), economy, environment.

SECTION 3: Community Profile

CHARACTERISTICS OF CHITTENDEN COUNTY

Chittenden County is located in northwestern Vermont between Lake Champlain on the west and the highest peaks of the Green Mountains on the east. Chittenden County is Vermont's most populous county. It serves as the economic center for northwest Vermont given its numerous large and small businesses. The County's nearly 654.32 total acres include diverse landscapes: forests, farms, water bodies, small cities, suburban areas, and villages.

Founded in 1787, Chittenden County is home to about 168,323 residents living in 19 municipalities that range in population size from 29 to almost 45,000 residents (2020, www.census.gov). The County is the heart of the Burlington – South Burlington Metropolitan Statistical Area (the economic engine of Vermont); home to the state's largest higher education institution, health care facility, and private sector employer; and nationally recognized as having an outstanding quality of life. Chittenden County is growing, and at a rate higher than the rest of Vermont, the New England region, and the United States as a whole. As reported by the US Census, the County's population grew 7.5% from 2010 to 2020 compared to 2.8% for all of Vermont, 2.6% for the six New England states combined and 7.4% for the United States. Located here are the state's largest university and medical facility, University of Vermont and UVM Medical Center (frequently referenced by its acronym, "UVM", which is the Latin abbreviation for *Universitas Viridis Montis* (in English, "University of the Green Mountains"); the largest employer, Global Foundries; and the largest number of cultural facilities and visitor services. The combination of cultural, social, economic, and political forces present in the area is perhaps the most complex in Vermont and has led to considerable change in the county.

The county is also geographically diverse. Its western border is formed by Lake Champlain, which is approximately 124 miles long, up to 12 miles in width, abuts the State of New York, and stretches into the Canadian province of Quebec. The Lake is a linchpin to the regional tourism industry attracting domestic and foreign visitors interested in experiencing its natural beauty, history, and recreational opportunities. The Lake also serves as the primary source of drinking water for a large portion of the region. The other major defining features are the Winooski River and the Lamoille River that flow east to west across the County before emptying into Lake Champlain. Both of these rivers originate in northeast Vermont and respectively are 90 and 85 miles in length. The flow of both is restricted by various private power producing dams. Flowing into these two major rivers, as well as directly into Lake Champlain, are tributaries and smaller rivers, such as the Browns River, the Huntington River, and the LaPlatte River, and numerous streams and creeks.

The communities along the Lake from Milton in the north to Charlotte in the south are relatively flat in general, although localized topography is often more variable. Moving eastward the landscape shifts with only the areas of river bottom being flat with the foothills of the Green Mountains becoming the defining feature. The easternmost communities of Bolton, Huntington, and Buel's Gore, and portions of Hinesburg, Underhill, and Jericho, are nestled in the Green Mountains. These uplands, or "hill country," are visibly emblematic of "postcard Vermont."

While Lake Champlain, local waterways, agricultural lands, forests, and the Green Mountains provide natural and aesthetic value to the region, they also set the stage for the types of natural hazards commonly affecting the county. Inundation from flooding occurs along Lake Champlain and 22 major rivers, while fluvial erosion occurs not only along these rivers but on numerous smaller rivers, creeks, and streams that are widely distributed throughout the county. Severe rainstorms and severe winter storms can occur anywhere. However, their effects are most dramatic in the upland communities, where gravel roads can be easily washed out by a sudden influx of rain or closed by downed, ice-heavy branches and trees with massive snow loads. These natural resources, especially Lake Champlain and local rivers and streams, also represent a responsibility to the municipalities and their residents and businesses. Proper long-term management towards sustainability of these resources can be and are threatened by technological, man-made hazards such as water pollution or hazardous materials.

The residential, commercial, industrial, and institutional built environment is concentrated in the core urban and suburban communities of Burlington, Winooski, South Burlington, Williston, Shelburne, Essex, Essex Junction, Colchester, and Milton. Rural populations are scattered along the road system with limited pockets of density at village locations. Farming operations (dairy, beef, vegetables, etc.) are distributed throughout the county, however there is more such land use in the towns of Milton, Colchester, Westford, Charlotte, Richmond, Hinesburg, Huntington, Jericho, and Underhill.

Over the past 45 years, residents have seen the regional Burlington area transformed from farmland to an urban and suburban landscape supported by a service and manufacturing economic base; however, according to the National Land Cover Datasets, over 80 percent of the county still remains as undeveloped forests and farmland.

Geography and Environment

Chittenden County is comprised of 19 municipalities. Eighteen of the 19 jurisdictions within the county participated in the *2022 Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan* (MJAHMP) update. (The Town of Colchester opted to develop a single jurisdiction plan which was completed in early 2022.) For clarity and as applicable, this 2022 MJAHMP update includes some data regarding Colchester.

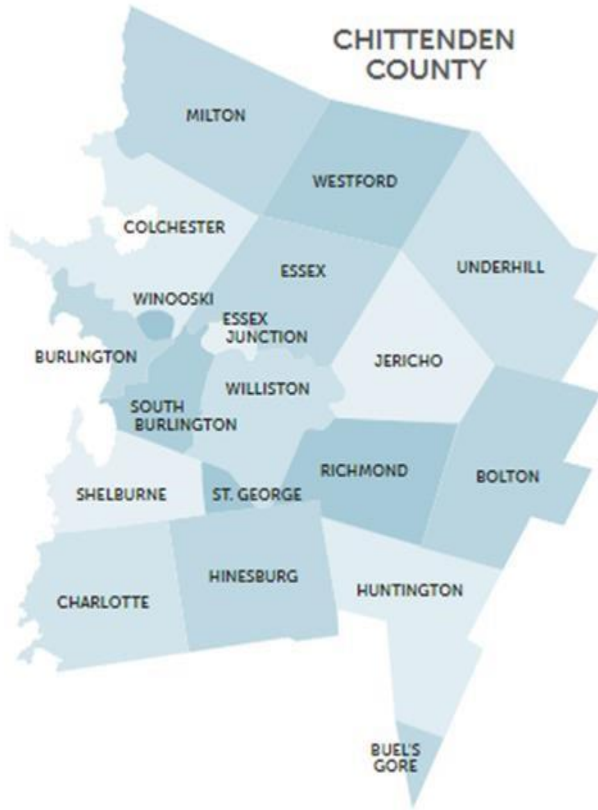


Figure 3.1: Chittenden County Planning Area[2]

Table 3.1: Total Chittenden County and Jurisdictional Land Area, in square miles[3]

Total Land Area in Square Miles			
Jurisdiction	**Total Areas**	**Land Area**	**Water Area**
Chittenden County	654.32	536.79	97.53
Bolton	42.5	42.2	0.3
Buels Gore	5	4.92	0.8
Jurisdiction	**Total Areas**	**Land Area**	**Water Area**

[2] Chittenden County Regional Planning Commission [2]
[3] Ibid.

Total Land Area in Square Miles			
Burlington	15.49	10.3	5.19
Charlotte	50.3	41.3	9.0
Colchester	58.6	36.3	22.3
Essex	39.3	38.8	0.5
Essex Junction	4.74	4.57	0.17
Hinesburg	39.8	39.4	0.4
Huntington	38	38	0.0
Jericho	35.6	35.4	0.2
Milton	60.9	51.5	9.4
Richmond	32.7	32.2	0.5
Shelburne	45.1	24.3	20.8
South Burlington	29.58	16.49	13.09
St. George	3.6	3.6	0
Underhill	51.4	51.4	0
Westford	39.3	39.1	0.2
Williston	30.6	30.1	0.5
Winooski	1.51	1.43	0.08

Topography

Vermont is nicknamed the Green Mountain State because the Green Mountains run through the middle of the state. The town of Underhill in Chittenden County is home to the highest summit in the state: Mount Mansfield, which has a peak elevation of 4,393 feet above sea level. Vermont's Lake Champlain is the sixth largest body of fresh water in the United States.

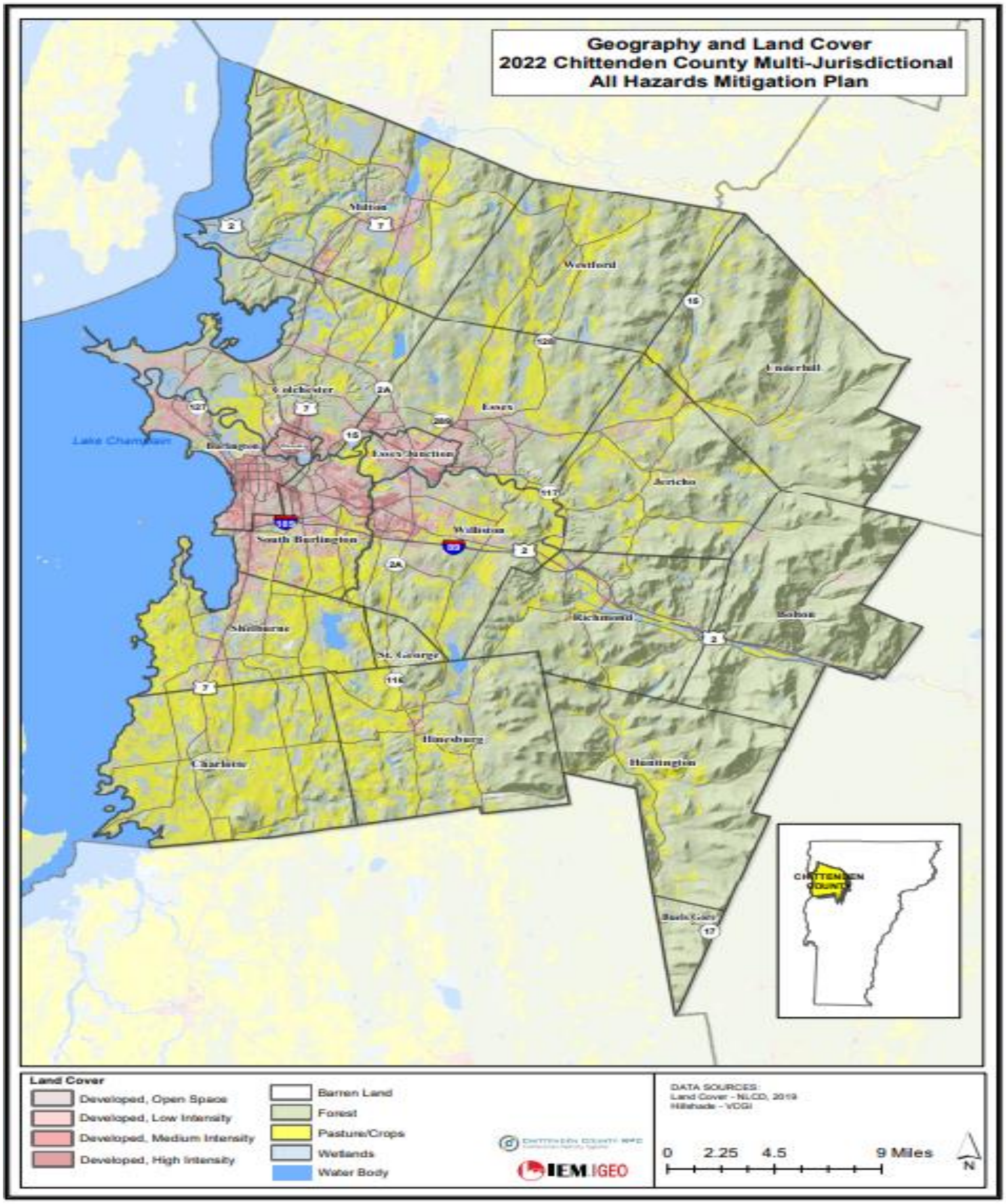


Figure 3.2: Chittenden County Geographic and Land Cover[4]

[4] Chittenden County Regional Planning Commission, September 2021

The state is divided into six physiographic regions.[5] These regions are determined by the age and type of rock in the area, by the landscape of the area, such as lowlands, hills, or mountains, and by the climate of the area. The planning area is traversed by three of the six regions.

- **Vermont Lowland (Champlain Valley)**
  This valley borders Lake Champlain and is sometimes called the Vermont Lowland. It is fertile farmland, with dairy farms, apple orchards and fields of corn, hay, oats, and wheat. Burlington, Vermont's largest city is in the Champlain Valley.
- **Green Mountains**
  The Green Mountain Region is in central Vermont. The Northfield, Worcester, and other lower mountain ranges also make up this region. The Green Mountains are an important source of minerals such as, granite, marble, talc, and slate. It is also the center of the state's tourism industry.
- **Vermont Valley**
  Located in western Vermont, this small strip of land is comprised of small rivers and river valleys that runs from the border of Massachusetts in the south into central Vermont. Located in the Vermont Valley are the Baton Kill and Waloomsac Rivers.

Population and Demographics

The official 2020 Chittenden County population is 168,323[6]. Overall, Chittenden County experienced an increase in population between 2010 and 2020 by 11,778, or an increase of 0.07%. Between 2010 and 2020, the Towns of Buel's Gore and Huntington, experienced a population decline while the rest of the municipalities experienced population growth. The Cities of Burlington (2,326), Essex (2,507), and South Burlington (20,292) experienced the greatest population growth over this same time period.

Table 3.2: Chittenden County Population Trends, 2010 - 2020[7]

Jurisdiction	2010	2020	Net Change from 2010-2020, by number	Net Change 2010-2020, by percent
Chittenden County	156,545*	168,323	11,778	7.52%
Bolton	1,182	1,301	119	10.06%
Buels Gore	30	29	-1	-3.3%
Burlington	42,417	44,743	2326	5.48%
Charlotte	3,754	3,912	158	4.2%
Colchester				

[5] https://www.ereferencedesk.com/resources/state-geography/vermont.html
[6] United States Census, 2020.
[7] Chittenden County Regional Planning Commission, 2021

Jurisdiction	2010	2020	Net Change from 2010-2020, by number	Net Change 2010-2020, by percent
Essex	19,587	22,094	2507	12.79%
Essex Junction	9271	10,590	1319	14.222%
Hinesburg	4396	4,698	302	6.86%
Huntington	1,938	1,934	-4	- .20%
Jericho	5,009	5,104	95	1,89%
Milton	10,352	10,723	371	3.58%
Richmond	4,081	4,167	86	2.10%
Shelburne	7,144	7,717	573	8.02%
South Burlington	17,904	20,292	2388	13.33%
St. George	731	794	63	8.62%
Underhill	3,016	3,129	113	3.74%
Westford	2,029	2,062	33	1.62%
Williston	8,698	10,103	1405	16.15%
Winooski	7,267	7,997	730	10.048%

Table 3.3: Chittenden County Demographics, 2020[5]

Jurisdiction	White	African American	Hispanic	Asian	Native American	2 or More Races
Chittenden County	90.3%	2.5%	2..5%	4.6%	0.2%	2.3%
Bolton	98.15%	0.10%	0.31%	0.21%	0.41%	0.93%
Buels Gore	100%	-	-	-	-	-
Burlington	85.3 %	5.7%	3.1%	5.8%	0.2 %	2.8%
Charlotte	97.93%	0.20%	0.70%	0.59%	0.06%	0.45%
Colchester						
Essex	87.1 %	2.6%	2.1%	5.1%	0.1%	4.7%
Essex Junction	83.7 %	2.4 %	2.4 %	8.0 %	-	5.4 %
Hinesburg	96.89%	1.68%	-	-	-	-
Huntington	97.47%	0.38%	0.38%	0.48%	0.1%	1.34%
Jericho	97.3 %	0.8 %	1.7 %	0.4 %	0.6 %	0.7%
Milton	97.3 %	1.1 % %	0.2 %	0.1 %	0.6 %	1.0%
Richmond	98.36%	0.05	0.83%	0.51%	0.12%	0.86%
Shelburne	95.9 %	0.9 %	3.0 %	1.1 %	0.6 %	1.5%
South Burlington	90.0 %	1.2 %	3. 7%	5.0 %	0.5 %	2.0%
St. George	98.14%	0.57%	1.15%	-	0.14%	1.15%

Underhill	98.45%	0.27%	0.70%	0.20%	0.13%	0.60%
Westford	97.2%	0.3%	0.8%	0.3%	0.4%	1.5%
Williston	92.8 %	1.8 %	0.9 %	2.2 %		1.7%
Winooski	77.4 %	2.7 %	2.7 %	16.8 %	0.2 %	1.4%

Table 3.4: Special Population Chittenden County Demographics - 2020[6]

Jurisdiction	Below Poverty Level	Very Young (Under 5)	Elderly (65 and over)	Disabled
Chittenden County	8.5%	4.6%	15.6%	8.9%
Bolton	5.3%		4.6%	
Buels Gore				
Burlington	26.4%	3.2%	11.9%	9.9%
Colchester				
Charlotte	5.5%		7.7%	
Essex	7.2%	4.5%	15.1%	6.0%
Essex Junction	7.1%	5.9%	13.1%	6.8%
Hinesburg	6.0%			
Huntington	6.0%		5.4%	
Jericho	4.5%	7.4%	14.8%	5.4%
Milton	3.1%	6.7%	13.4%	11.1%
Richmond	5.1%		6.8%	
Shelburne	0.0%	1.3%	27.6%	4.2%
South Burlington	6.6%	4.5%	18.5%	10.0%
St. George	8.9%		6.7%	
Underhill	5.2%		5.7%	
Westford	1.7%		8.7%	
Williston	6.5%	6.3%	17.0%	6.9%
Winooski	29.5%	5.8%	11.6%	17.0%

Land Use, Growth and Development

A general analysis of land uses, development trends, and zoning within the planning area is an important factor in formulating mitigation options that influence future land use and development decisions. In many cases, local development policies greatly influence the degree of future vulnerability in communities across the region. Changes in urban and agricultural land cover may help to highlight areas within the county that should be considered in long-term comprehensive plans. To identify these areas, the *Chittenden County Regional Plan, – Environment, Community, Opportunity, and Sustainability*, also known as the *ECOS Plan,* uses the Planning Area concept to identify places that share similar existing features and future planning goals. The Planning Areas reflect current municipal zoning, as well as describe the appropriate type of future growth expected in each Planning Area; but the exact uses and allowable densities are determined by local ordinances. The Planning Areas also aim to illustrate a regional picture of future land use policies in the county necessary to promote a regional conversation about land use in Chittenden County municipalities. The six regional Planning Areas are depicted on the Future Land Use Plan Map - Center, Metro, Suburban, Village, Rural, and Enterprise. Center Planning Areas are intended to be regional centers or traditional downtowns that serve the municipality and beyond, and contain a mix of jobs, housing, and community facilities.

Table 3.5: Chittenden County Land Use Planning Area Descriptions[8]

Center Planning Areas
Center Planning Areas contain the county's highest density and largest-scale developments with residential densities generally ranging from seven to more than 60 dwelling units per acre. Center Planning Areas may contain a state designated New Town Center, Growth Center, Tax Increment Financing District, or high-density Village Center. Development in downtown centers primarily happens through infill development of underutilized vacant land and adaptive reuse of older structures whereas, development in municipal growth centers occurs in targeted areas that will accommodate future anticipated growth. These land uses are locally planned and managed to coexist successfully with neighborhoods and natural areas. Places within Center Planning Areas are served by wastewater facilities, other infrastructure, and offer a variety of transportation options, including nonmotorized modes
Metro Planning Areas
Metro Planning Areas are areas where local zoning authorizes places to accommodate jobs and housing in a compact development pattern that supports transit service and encourages pedestrian activity; and are within the sewer service area. Commercial land uses found in the Metro Planning Area are intended to serve the nearby residential area. Existing densities within Metro Planning Areas are typically higher than those found in the Suburban, Rural, Village, and Enterprise Planning Areas and generally range between four and 20 dwelling units per acre. Future development in the metro area should be encouraged to occur at the higher end of this range to ensure that there are adequate housing and jobs in these areas.
Suburban Planning Areas

[8] Chittenden County Regional Planning Commission

Suburban Planning Areas are areas near a Center Planning Area, Metro Planning Area, Village Planning Area, or Enterprise Planning Area where local zoning authorizes future development to occur at scales, densities, and uses compatible with existing development and with general residential densities greater than one and less than four and a half dwelling units per acre. Many parts of the Suburban Planning Area already have been developed, often in suburban styles of development and are predominantly within the sewer service area. Future development and redevelopment should be publicly sewered, minimize adverse impacts on natural resources, and protect strategic open space.

Enterprise Planning Areas

Enterprise Planning Areas are areas where local zoning authorizes a future concentration of employment uses that attract workers from the county and multicounty region. Development should have adequate wastewater capacity and access to transit or be near these services. Typically, this area encompasses major employers or a cluster of single employers and has current or planned transit service.

Village Planning Areas

Village Planning Areas are areas where local zoning authorizes a variety of future residential and nonresidential development at densities and scales in keeping with the character of a Vermont village, generally between two and 12 dwelling units per acre if sewered and between two-tenths and four units per acre if not sewered. Village Planning Areas are compact areas of mixed-use activities that maintain the character of a Vermont village. This is intended to serve its local surroundings as a place where people can live, work, shop and recreate.

Rural Planning Areas

Rural Planning Areas are areas where regional and town plans promote the preservation of Vermont’s traditional working landscape and natural area features. The Rural Planning Area also provides for low density commercial, industrial, and residential development (generally one dwelling unit per acre or less) that is compatible with working lands and natural areas so that these places may continue to highlight the rural character and self-sustaining natural area systems. Development is typically outside the sewer service area.

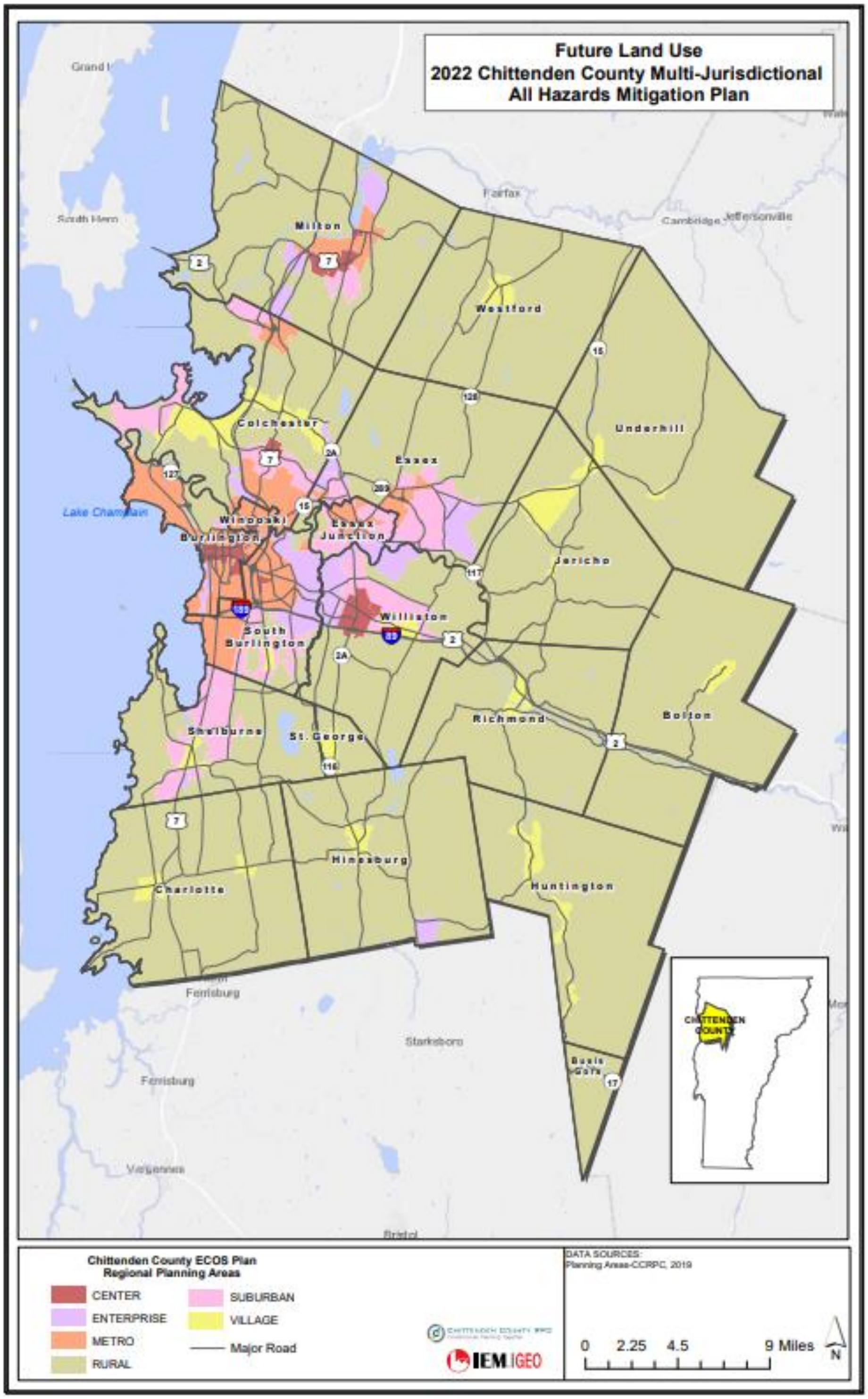


Figure 3.3: Future Land Use Map for Chittenden County[9].

[9] Chittenden County Regional Planning Commission, September 2021.

The most densely populated jurisdictions in Chittenden County are Winooski (5,592.3 persons per square mile), Burlington (4,343.9), Essex Junction (2,317.2), and South Burlington (1,230.5). The municipalities with the lowest density are Bolton and Buel's Gore.

Table 3.6: Population Density for Chittenden County Jurisdictions, 2020[10]

Population of Chittenden County			
Jurisdiction	Total Population 2020 Census	Total Land (Square Miles)	Population Density (Per Square Mile)
Chittenden County	168,323	536.79	313.5
Bolton	1,301	42.2	30.8
Buels Gore	29	4.92	5.8
Burlington	44,743	10.30	4,343.9
Charlotte	3,912	41.3	94.7
Colchester			
Essex	22,094	38.8	596.4
Essex Junction	10,590	4.57	2,317.2
Hinesburg	4,698	39.4	119.2
Huntington	1,934	38.0	50.8
Jericho	5,104	35.4	144.1
Milton	10,723	51.5	208.2
Richmond	4,167	32.2	129.4
Shelburne	7,717	24.3	317.5
South Burlington	20,292	16.49	1,230.5
St. George	794	3.6	220.5
Underhill	3,129	51.4	60.8
Westford	2,062	39.1	52.7
Williston	10,103	30.1	335.6
Winooski	7,997	1.43	5,592.3

Table 3.7 Future Population Growth Trends

10 U.S. Census Bureau QuickFacts: Vermont

Jurisdiction	2020[11]	2030[12]	Net Change from 2020-2030, by numbers	Net Change 2020-2030, by percent
Chittenden County	168,323	172,596	4273	2.5 %
Bolton	1,301	1,208	-93	-7.1%
Buels Gore	29	32	3	10.3%
Burlington	44,743	45,578	835	1.9%
Charlotte	3,912	4,121	209	5.4%
Colchester				
Essex	22,094	22,577	483	2.2%
Essex Junction	10,590			
Hinesburg	4,698	4,747	49	1.0%
Huntington	1,934	2,106	172	8.9%
Jericho	5,104	5,247	143	2.8%
Milton	10,723	11,755	1032	9.6%
Richmond	4,167	4,238	71	1.7%
Shelburne	7,717	8,474	757	9.8%
South Burlington	20,292	20,273	-19	-.10%
St. George	794	754	-40	-5.0%
Underhill	3,129	3,174	45	1.4%
Westford	2,062	2,225	163	7.9%
Williston	10,103	10,239	136	1.3%
Winooski	7,997	7,693	-304	-3.8%

Built Environment and Community Lifelines

A lifeline is an infrastructure sector that provides an indispensable service which enables the continuous operation of critical business and government functions and is critical to human health and safety or economic security. Infrastructure associated with Community Lifelines[13] is a mix of public and private ownership and has many interdependencies. As an example, maintaining the function of a hospital during an event that results in a power failure is dependent on communication, water and sewer infrastructure, and access to temporary power to prevent interruption of services. Assessing these sectors helps to identify root causes of impacts and consequences from previous hazard events and prioritizes the highest issue areas and interdependencies in order to create effective mitigation solutions.

[11] U.S. Census Bureau QuickFacts: Vermont
[12] CCRPC-Chittenden County Municipal Population Estimates
[13] Community Lifelines are defined by the Federal Emergency Management Agency.

Figure 3.4: FEMA Community Lifeline Components

Each of the seven Community Lifeline components is comprised of subcomponents that establish the parameters of the lifeline.

The information related to Community Lifelines and critical assets in Chittenden County presented in this section has been collected from multiple sources, including each participating jurisdiction, the Chittenden County Regional Planning Commission (CCRPC), and Hazus (Version 4.2).

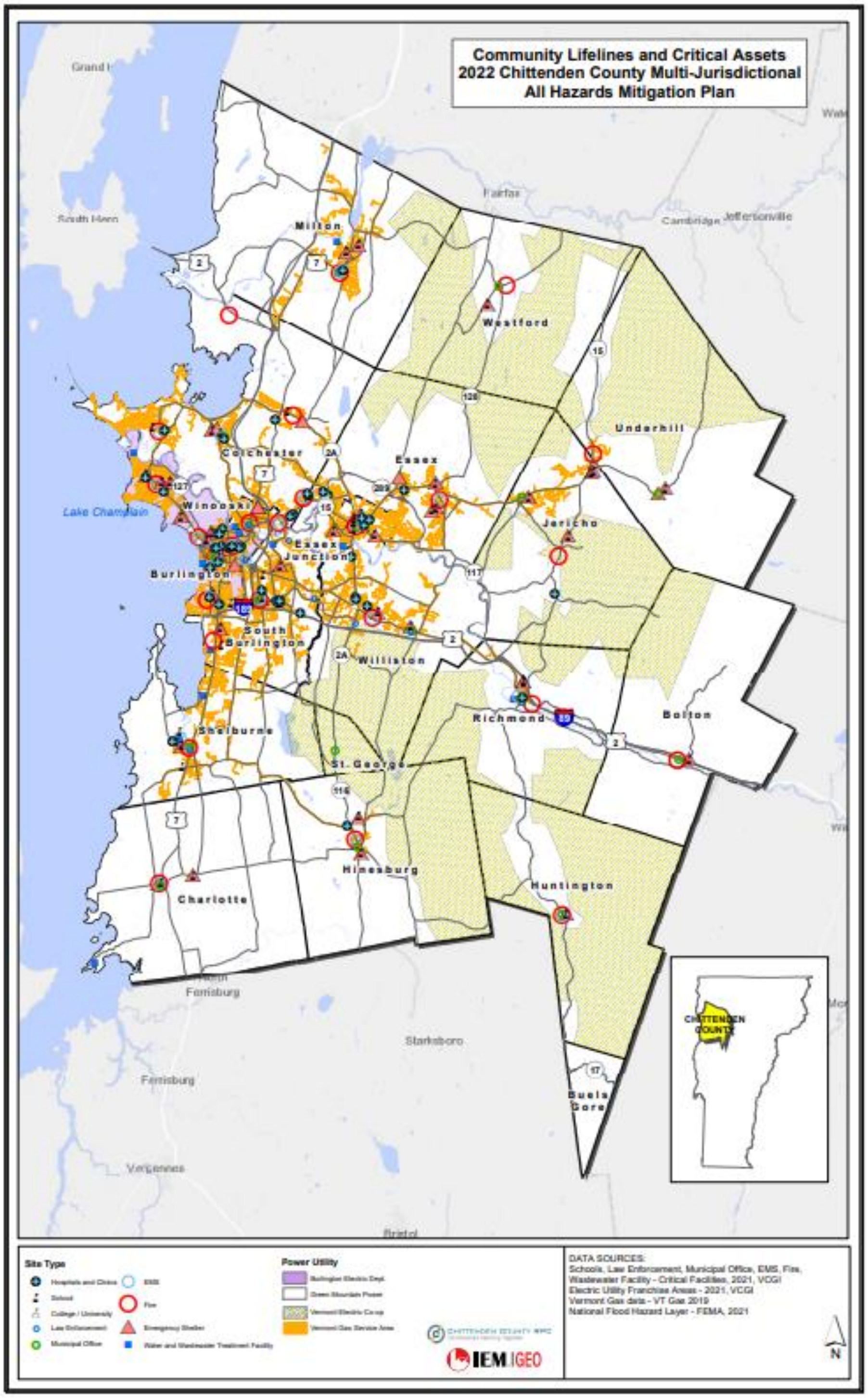


Figure 3.5: Community Lifelines and Critical Assets Locations, Chittenden County[14]

[14] Chittenden County Regional Planning Commission, September 2021.

Table 3.8: Number of Community Lifelines and Critical Assets, by Jurisdiction[3]

Jurisdiction	Safety and Security	Food, Water, Shelter	Health and Medical	Energy	Communications	Transportation	Hazardous Materials	Education	Cultural/ Historical	High Hazard Dams
Bolton	5	2			2	1	N/A	1		
Buels Gore							N/A			
Burlington	13	14	5	5	3	3	N/A	17	3	
Charlotte	3	1		1	1	2	N/A	1		
Essex	10	10	4	4	2	2	N/A	9	1	
Essex Junction	10	10	4	4	2	2	N/A	9	1	
Hinesburg	5	7	1	1	1		N/A	2	1	
Huntington	4	1			1		N/A	1		
Jericho	4	1	1	1	2		N/A	4	1	
Milton	7	4	2	1	1	1	N/A	2	1	
Richmond	2	3	1	1		1	N/A	2		
Shelburne	8	6	2	1	2	1	N/A	4		
South Burlington	8	7	4	3	10	1	N/A	10	2	
St. George	1	1					N/A			
Underhill	4	3				2	N/A	1		
Westford	4	2	2	1		1	N/A	1		
Williston	10	4	2	4	4	1	N/A	5		
Winooski	5	4			1	1	N/A	4		
County Totals	101	74	30	30	41	29	N/A	71	10	

Safety and Security

Table 3.9: Safety and Security Assets, by Jurisdiction[15]

[15] Jurisdictions and Chittenden County Regional Planning Commission.

Municipality	Fire	Police	Emergency Medical Services (EMS)
Bolton	Bolton VFD	VT State Police	Richmond Rescue
Buels Gore	Starksboro VFD*	VT State Police	Richmond Rescue; Bristol Rescue*; Mad River/Waitsfield Rescue*
Burlington	Burlington FD	Burlington PD	Burlington FD/EMS; UVM Rescue
Charlotte	Charlotte VFD VT	State Police	Charlotte Rescue
Colchester	Colchester Fire Department	Colchester PD	Colchester Rescue (inc. Colchester Tech Rescue); St. Michael's Rescue
Essex	Essex VFD	Essex PD	Essex Rescue
Essex Junction	Essex Junction VFD	Essex PD	Essex Rescue
Hinesburg	Hinesburg VFD	Hinesburg PD	Hinesburg FD 1st Response; St. Michael's Rescue
Huntington	Huntington VFD	VT State Police	Huntington FD 1st Response; Richmond Rescue
Jericho	Underhill-Jericho FD	VT State Police	Essex Rescue; Richmond Rescue in south Jericho; Williston Rescue
Milton	Milton VFD	Milton PD	Milton Rescue
Richmond	Richmond VFD	Richmond PD	Richmond Rescue, UVM Rescue
St. George	St. George Hinesburg VFD	State Police	Hinesburg FD 1st Response; St. Michael's Rescue
Shelburne	Shelburne VFD	Shelburne PD	Shelburne Rescue, UVM Rescue
South Burlington	S. Burlington FD	S. Burlington PD	S. Burlington FD/EMS, UVM Rescue
Underhill	Underhill-Jericho FD	VT State Police	Essex Rescue
Westford	Westford VFD	VT State Police	Essex Rescue; Fairfax Rescue*
Williston	Williston FD	Williston PD	St. Michael's Rescue & Williston FD/EMS
Winooski	Winooski VFD	Winooski PD	St. Michael's Rescue, UVM Rescue

Food, Water, Shelter

Food commodities are available throughout Chittenden County from public retail providers, wholesalers, and contracted services for specific institutions and facilities. Additional contracts may be entered into for post-disaster needs.

Water and wastewater services are provided in Chittenden County through multiple utilities.

Table 3.10: Water and Sewer Providers in Chittenden County[16]

[16] Chittenden County Regional Planning Commission, 2021.

Water Service Provider	Service Areas
Champlain Water District (CWD)	Colchester, Essex, Essex Junction, Jericho, Milton, Shelburne, South Burlington, Williston and Winooski
City of Burlington Water Resources Division	City of Burlington and Colchester Fire Department #2
City of Burlington Water Resources Division	Burlington East-City of Burlington and University of Vermont Medical Center Main Campus
Jericho-Underhill Water District	Jericho, Underhill
Town of Richmond Water Resources Department	Richmond
Town of Hinesburg	Hinesburg
Sewer Service Provider	**Service Areas**
City of Burlington Water Resources Division	City of Burlington and Colchester Fire Department #2
Richmond	Richmond,
Hinesburg	Hinesburg
Burlington Main	City of Burlington
Burlington North	City of Burlington
Colchester FD#1	City of South Burlington
Essex	Town of Essex
Essex Junction	Village of Essex Junction
Fort Ethan Allen (PVT)	Fort Ethan Allen (PVT)
Hinesburg	Town of Hinesburg
Milton	Town of Milton
Richmond	Town of Richmond
Shelburne-1	Town of Shelburne
Shelburne-2	Town of Shelburne
South Burlington Bartlett Brook	City of South Burlington
South Burlington Airport Parkway	City of South Burlington
Camp Johnson	City of South Burlington
Williston	Village of Essex Junction
Winooski Water Pollution Control Facility	City of Winooski

Health and Medical

Listed below are health and medical facilities offering patient care, urgent care, emergency rooms, and other healthcare services in Chittenden County:

- The University of Vermont Medical Center

- UVM Medical Center-Cancer Center
- Vermont Children's Hospital
- Marathon Health
- Community Health Center of Burlington
- Chittenden County Health Department

Energy

Table 3.11: Energy Providers in Chittenden County, 2022[17]

Electrical Power Service	Service Areas
Burlington Electric Department	City of Burlington
Green Mountain Power Corporation	Most of communities in County with exception of Central Vermont Public Service Corporation service area
Central Vermont Public Service Corporation	Milton, Westford, Underhill, Jericho
Vermont Electric Co-op	Based in Johnson and has service areas in Chittenden County
Gas Service	**Service Areas**
Vermont Gas Company	Most of Burlington, South Burlington, Winooski, and Essex Junction, significant portions of Milton, Colchester, Essex, Williston, and Shelburne, Limited service in Underhill, Hinesburg, Richmond, and Jericho.

Communications

Increasing reliance on telecommunication infrastructure by individuals, businesses, and government could cause vulnerabilities which emergency managers should take into consideration in pre- and post-incident planning and operations. Listed below are primary telecommunication providers for residents and business located in Chittenden County.

Table 3.12: Communications Providers in Chittenden County, 2022[18]

Telecommunication Provider	Service Areas
Consolidated Communications	Countywide
Xfinity	Countywide

[17] Chittenden County Regional Planning Commission, 2021.
[18] Chittenden County Regional Planning Commission, 2021.

Telecommunication Provider	Service Areas
Waitsfield/Champlain Valley Telecommunication	Rural areas, Huntington, Jericho.
Burlington Telecommunication	Burlington, Winooski

Transportation

Chittenden County is served by a host of transportation facilities that provide regional and international travel (to Canada). Major interstate thoroughfares include I-89 and I-189. The former runs west from New Hampshire into Vermont, crossing the entire county. In the cities of Burlington and South Burlington, the I-89 turns north and, at the Canadian border, connects to a historic Route 133 that ends at the St. Lawrence River.

Additionally, the county includes other major roadways, including US 2, US 7, and US 7 Alt; and state roads VT 2A, VT F-5, VT 15, VT 17, VT 116; VT 117; VT 127; VT 128; and VT 289.

The Green Mountain Public Transit system provides public transit regional lines connecting Chittenden County to Washington, Franklin, and Addison Counties.

New England Central Railroad operates its entire line on land owned by one of the largest railroads in North America, Canadian National, which also owns the line between East Alburg and Montreal. The Railroad also hosts Amtrak passenger service, the Vermonter, which runs once a day, southbound in the morning and northbound in the afternoon between St. Albans, New York City's Penn Station and Union Station in Washington, D.C.

Vermont Railway originates in Burlington and heads due south through South Burlington, Shelburne and Charlotte in a corridor located between the shore of Lake Champlain and U.S. Route 7. The line continues down to Middlebury, then to Rutland and terminates in Hoosick Junction, New York. A new Amtrak passenger service from Burlington to New York City, an extension of the Ethan Allen Express, will start in July 2022.

The Burlington International Airport is the largest airport in the state and is located in the City of South Burlington. It is a hub for seven major and local airlines that provide direct flights to 19 major U.S. cities, from Boston to Orlando, and New York City/Newark to Denver. Additionally, the airport is home to a unit of the Vermont Air National Guard fleet of F-35s, a Black Hawk helicopter air ambulance service and a maintenance and repair facility for the air crafts.

Hazardous Materials

The Hazus database identifies one oil refinery, one natural gas facility and thirteen natural gas pipeline locations within Chittenden County.

Additional Community Assets

Education

There are numerous public-school districts located in Chittenden County serving one or more municipalities

- Burlington School District
- Chittenden South Supervisory District Union (Charlotte, Hinesburg, Shelburne, St. George and Williston)
- Essex Westford School District (Essex, Essex Junction and Westford)
- Colchester School District
- Milton School District
- Mount Mansfield Unified Union School District (Bolton, Huntington, Jericho, Richmond and Underhill)
- South Burlington School District
- Winooski School District

Additionally, there are four colleges and universities located in Chittenden County:

- University of Vermont (Burlington)
- Champlain College (Burlington)
- St. Michaels College (Colchester)
- Community College of Vermont (Winooski)

Recreational, Cultural and Historic Sites, and Assets

Almost all parks in Chittenden County are public spaces open to the general public, though there are some private parks. Most local municipalities within the County have a Parks Department that is responsible for maintaining City Parks, Town Greens, Athletic Parks, and similar open spaces. Many of these sites support recreation and the residents' health through preservation of environmentally sensitive land and resources and areas of historic significance as well as provision of recreational facilities and services.

Economy and Industry

Chittenden County is the home of a vibrant, well-educated population, and is committed to ensuring that the positive economic growth that has occurred over the past several decades continues in the future.

The distribution of single and multi-family housing, including mobile homes depicted in Figure 3.5 illustrates the accessibility to employment locations countywide. Maps of each municipality are presented in the jurisdictional annexes with a more easily visualized pattern.

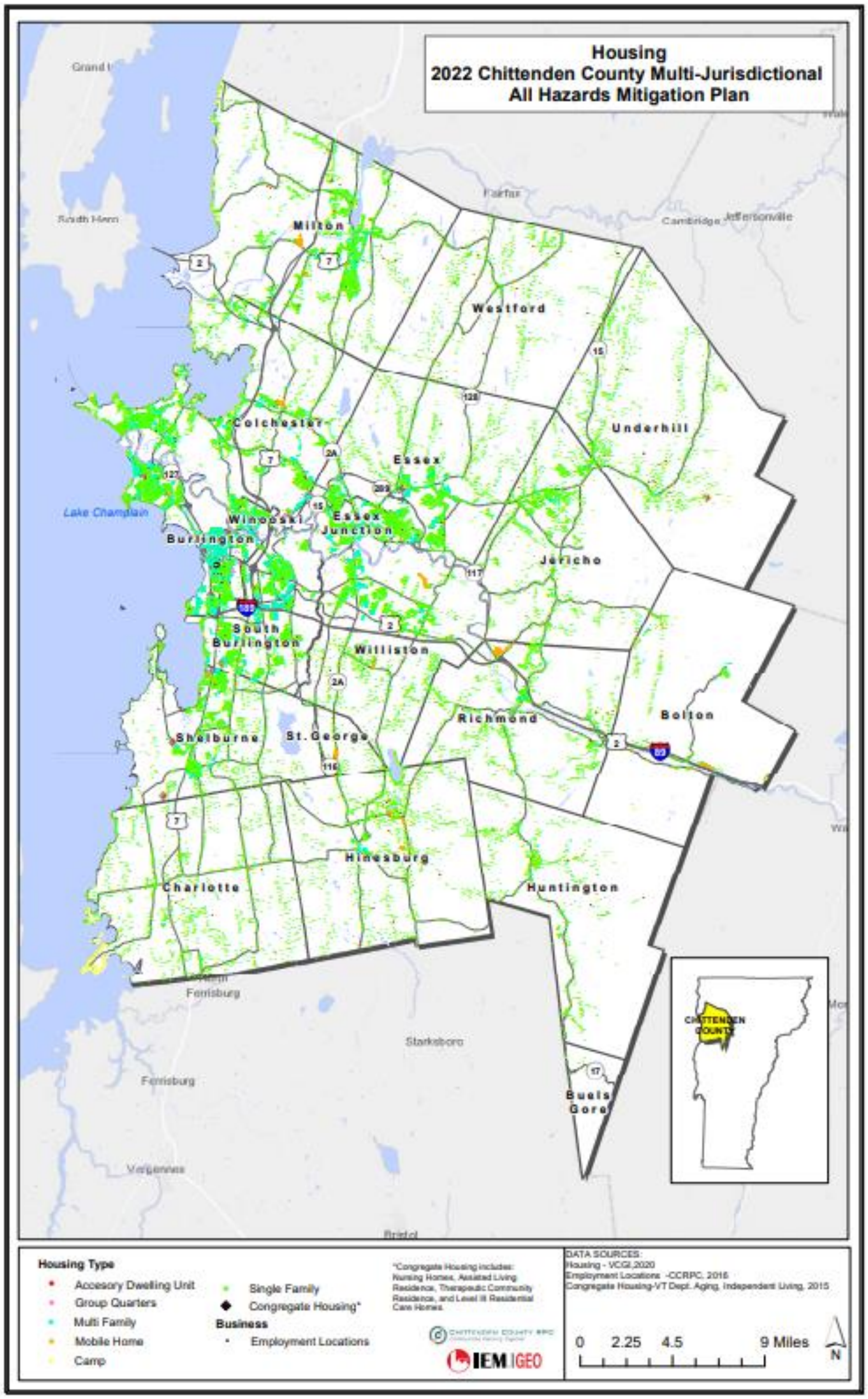


Figure 3.6. Housing and Employment[19]

19 Chittenden County Regional Planning Commission, 2021.

The economy of Chittenden County, VT employs 93,429 people. The largest industries in Chittenden County, VT are Management, Business, Science, and Arts (48,964 people), Sales and Office (16,414 people), and Service (14,9614 people), and the highest paying industries are Education, Utilities ($71,719), Professional, Scientific and Technical Services ($64,087), and Public Administration ($60,576).

Table 3.13: Chittenden County, Economic Characteristics, 2020[20]

OCCUPATION	Number Employed
Civilian employed population 16 years and over	93,429
Management, business, science, and arts occupations	48,964
Service occupations	14,961
Sales and office occupations	16,414
Natural resources, construction, and maintenance occupations	5,237
Production, transportation, and material moving occupations	7,853
Industry	
Agriculture, forestry, fishing and hunting, and mining	722
Construction	4,106
Manufacturing	11,333
Wholesale trade	1,764
Retail trade	9,353
Transportation and warehousing, and utilities	1,984
Information	2,097
Finance and insurance, and real estate and rental and leasing	4,242
Professional, scientific, and management, and administrative and waste management services	10,013
Educational services, and health care and social assistance	29,366
Arts, entertainment, and recreation, and accommodation and food services	10,322
Other services, except public administration	3,578
Public administration	4,549

[20] Census - Table Results

Table 3.14: Chittenden County, Economic Characteristics, 2020[21]

Average Civilian Labor Force	Average Number Employed	Average Number Unemployed	Average Weekly Wage	Per Capita Income	Per centage Below Poverty
97,575	93,429	4,146	$1,132	$41,136	8.5%

Table 3.15: Major employers in Chittenden County, 2016[22]

Name	Location	Primary Business	Employees
UVM Medical Center	Burlington	Physicians & Surgeons	7,351
7351 IBM (Global Foundries)	Essex Junction	Computers-Electronic Manufacturers	4,000
University Of Vermont	Burlington	Universities & Colleges Academic	3,446
People's United Bank	Burlington	Banks	1,000
DEALER.COM	Burlington	Website Hosting	838
Ben & Jerry's Homemade Inc	South Burlington	Ice Cream Parlors	735
GE Healthcare	South Burlington	Computer Services	700
Green Mountain Power Corp	Colchester	Electric Contractors	605
St Michaels College	Colchester	Universities & Colleges Academic	470
Burton Snowboards Mfg. Ctr.	Burlington	Manufacturers	375
Champlain College	Burlington	Universities & Colleges Academic	310
PC Construction Co	South Burlington	General Contractors	276
Note: Employee counts can include some positions located outside of Chittenden County.			

[21] Census - Table Results

[22] Vermont Business Directory; U.S. Bureau of Labor Statistics, New England Information Office, September 2020.

SECTION 4: HAZARD IDENTIFICATION AND RISK ASSESSMSENT

	Requirements
•	**§201.6(c)(2)(i)** [The risk assessment shall include a] description of the type, location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.
•	**§201.6(c)(2)(ii)** [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:
•	***§201.6(c)(2)(ii)(A)*** The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas.
•	***§201.6(c)(2)(ii)(B)*** An estimate of the potential dollar losses to vulnerable structures identified in this section and a description of the methodology used to prepare the estimate.
•	**§201.6(c)(2)(ii)(C)** Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

•	**§201.6(c)(2)(iii**) For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.
2022 *MJAHMP* Updates to Section 4	
Following the comprehensive review of All-Hazards in the 2018 *Vermont State Hazard Mitigation Plan (SHMP)*, and after conducting a hazard risk assessment, all hazards profiled in the 2018 SHMP were moved forward to this plan for consideration. This 2022 Chittenden County Plan Update includes justification for hazards that were eliminated from further consideration. In addition, changes were made to the list of natural hazards:	
•	**Invasive Species** and **Human Infectious Disease** were moved from technological and societal hazards, respectively, to the natural hazards list for a more focused review of risk and vulnerability. Following discussion about these hazards during the initial risk assessment ranking process, it was decided that both hazards should be fully profiled as natural hazards.
•	The population vulnerability assessment has been enhanced using two references. • Data from Healthy Vermont (VT Department of Health) reports and educational resources • The Social Vulnerability Index produced by the Centers for Disease Control and Prevention county-based report that includes vulnerability at the census track level for socioeconomic status; household composition/disability; race/ethnicity/language; and housing type/transportation.
	Data produced for the National Risk Index (NRI) was included in the consideration of probability and the vulnerability analysis for Flooding, Severe Rainstorm and Severe Winter Storm.
•	Specific data and information related to each hazard type has been reviewed and updated from the 2017 Plan.
•	The section was reorganized and updated for consistency with the review criteria.

Overview

The hazard identification and risk assessment (HIRA) provides the data and foundation for the mitigation actions and strategies that are provided in the Mitigation Strategy. The 2022 Chittenden County MJAHMP HIRA was developed after analyzing the 2017 MJAHMP, Vermont SHMP, and other local plans that include regional land use plans, emergency operations, and long-term development; examples include historical and statistical data, and updated data that indicates potential shifts in hazard risk and vulnerability. The process of developing effective mitigation actions that would improve the resiliency of Chittenden County to the effects of future disasters is informed by an understanding of how hazards of concern disrupt activities and operations of the county and its municipalities. Information about a hazard's characteristics, location, and impacts informs the extent of potential risk and vulnerability.

This section of the plan presents the hazard identification and risk assessment (HIRA) methodology, which includes detailed descriptions of ***natural, technological,*** and ***societal***

hazards known to impact the county and its municipalities and are considered a threat to the people, property, infrastructure, built environment, natural environment, economy, and/or disaster operations of each jurisdiction and to the county overall.

Review of Existing Mitigation Plans and Additional Research Sources

An initial step in identifying hazards was to understand past hazards and community vulnerabilities as presented in plans, studies, reports, and other documents.

Table 4.1: Existing Mitigation Plans and Resources Consulted in Developing the 2022 Plan Update

• *Chittenden County All-Hazards Multi-Jurisdictional All-Hazards Mitigation Plan*
• *2018 Vermont State Hazard Mitigation Plan*
• Chittenden County Regional Planning Commission reports and documents: annual work plan, *ECOS Plan* for environmental sustainability, and others
• Historical data of events that occurred since the 2017 MJAHMP was adopted, including input from subject matter experts and lessons learned from previous years
• *Data Collection Guide* developed by IEM and completed by each jurisdiction to provide input on hazards, vulnerabilities, jurisdictional capabilities, and jurisdictional priorities
• U.S. Federal Emergency Management Agency (FEMA)
• 2021 University of Vermont Climate Change Assessment
• FEMA Flood Insurance and Mitigation Administration (FIMA)
• Hazus, FEMA hazard analysis tool
• National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information (NCEI), Storm Events Database
• NOAA, National Weather Service
• Review of climate change studies and publications from local, state, national and international sources
• U.S. Environmental Protection Agency (EPA)
• FEMA Data Visualization Site
• Chittenden County Flood Insurance Rate Map, FEMA Map Service Center (MSC)
• U.S. Department of Transportation
• United States Geological Survey
• U.S. Department of Agriculture Forest Services Wildfire Risk to Communities Site
• FEMA, Federal Disaster Declarations for Vermont, and its counties
• Review of hazards identified in guidance materials provided by FEMA Region VII
• Chittenden County Flood Insurance Study, FEMA Map Service Center

- National Inventory of Dams
- FEMA National Risk Index
- Drought Reporter, National Drought Mitigation Center
- Centers for Disease Control and Prevention (CDC), Social Vulnerability Index
- Articles and publications accessed from the internet, each cited as mentioned
- Historical records, predictive models, and other verified data collected additional resources

Hazard Identification and Risk Assessment (HIRA)

The 2022 All-Hazards Mitigation Plan Update Committee (AHMPUC) identified hazards from the 2017 plan that remain relevant. In presenting these profiles, it is helpful to understand why the AHMPUC decided to include or eliminate a hazard in the current and previous plans.

Step 1: Identify Hazards for Initial Consideration

The initial step in identifying/updating the hazards for the 2022 plan update began with a review of hazards included in both the county's 2017 MJAHMP and the 2018 Vermont SHMP.

Step2: Select Hazards for Inclusion in the 2022 MJAHMP

For the 2022 Chittenden County *MJAHMP* update, the AHMPUC confirmed the six natural hazards profiled in the 2017 Plan should be retained. In addition, the group recommended that *Dam Failure, Human Infectious Disease*, and *Invasive Species* should be included as natural hazards to be profiled.

Table 4.2: Decisions for Inclusion of Natural Hazards in the *2022 MJAHMP* Update

Hazard Profile	Jurisdiction for Profile	Final Disposition in 2022 MJAHMP
Dam Failure	• History of previous occurrences with property loss. • Dam maintenance issues and extreme weather events could cause failures. • Numerous Federal Disaster Declarations for flooding. • High Hazard Potential Dam Grant Program criteria	Full profile/risk assessment and vulnerability analysis.

Hazard Profile	Jurisdiction for Profile	Final Disposition in 2022 MJAHMP
	relates to high and/or significant hazard dams.	
Extreme Temperatures	• History of extensive previous occurrences. • Addressed in the 2018 SHMP as Extreme Cold and Extreme Heat	**Minimally profiled to provide context** to address hazard preparedness and response activities
Flooding	• Extensive history of riverine flooding and high losses from previous floods. • History of damaging ice jams and flash floods. • Numerous Federal Disaster Declarations for flooding and related hazards. • Significant impact to critical infrastructure.	Full profile/risk assessment and vulnerability analysis.
Fluvial Erosion (Including Landslide)	• History of previous occurrences. • Significant impact to critical infrastructure.	Full profile/risk assessment and vulnerability analysis.
Human Infectious Disease [Hazard Profile moved from Societal Hazards]	• Increasing threat of infectious disease outbreaks, including influenza (H1N1) and coronavirus. • Two Federal Disaster Declarations (one Emergency on Major) in March and April 2020 for COVID-19. • Widespread recognition that appropriates mitigation actions save lives and reduce risk.	Full profile/risk assessment and vulnerability analysis.
Invasive Species [Hazard Profile moved from Technological Hazards]	• History of previous occurrences in multiple municipalities. • High potential impact to State and local economies • Potential for environmental impacts.	Full profile/risk assessment and vulnerability analysis.

Hazard Profile	Jurisdiction for Profile	Final Disposition in 2022 MJAHMP
Severe Rainstorm (Including Thunderstorm, High Wind, Hail, Lightning, Tornado and Tropical Storm/ Hurricane)	• Extensive history of frequent occurrences with health/safety, property, and crop losses. • 23 Federal Disaster Declarations since 1950 for severe storms. • Significant impact to critical infrastructure.	Full profile/risk assessment and vulnerability analysis.
Severe Winter Storm (Including Blizzard, Heavy Snow, and Ice Storm))	• Significant history of previous occurrences. • Potential for loss of life. • Significant impact to property and critical infrastructure.	Full profile/risk assessment and vulnerability analysis.
Wildfire	• History of previous occurrences • Potential for loss of life. • Potential for extensive property and crop loss. • Significant impact to critical infrastructure. • Potential for environmental impacts.	Full profile/risk assessment and vulnerability analysis.

Table 4.3: Additional Natural Hazards in the *2018 Vermont* SHMP Considered for the *2022 MJAHMP*

Hazard	Source	Final Disposition in 2022 MJAHMP
Drought	2018 Vermont State Hazard Mitigation Plan	Not included due to assessment of low risk and probability.
Earthquake	2018 Vermont State Hazard Mitigation Plan	Not included due to assessment of low risk and probability.
Landslide	2018 Vermont State Hazard Mitigation Plan	Integrated in the Fluvial Erosion full profile/risk assessment and vulnerability analysis.

The AHMPUC also reviewed technological and societal hazards described in the 2022 MJAHMP. These were not fully profiled; however, many are relevant because they trigger a loss of key services. They were discussed in the 2017 plan in a section called Loss of Key Services.

Table 4.4: Summary of Technological Hazards Discussed but Not Fully Profiled in the 2022 MJAHMP

Hazard	Is Location data available?	Is Extent data available?	Is Impact data available?
Technological Hazards			
Water Pollution	Impaired streams that lack adequate identified biota or local flora and fauna.	Phosphorus-loading for general locations is known but non-point sources (agricultural lands, developed lands, forests, etc. are varied and dispersed.	Annual budgetary impacts to individual municipalities are significant but vary depending upon location.
Hazardous Materials Incident	Storage locations are known. Incidents occurring during transportation could occur anywhere.	Rough estimates of spill amounts are recorded.	No formal data readily available on cleanup costs.
Power Loss	Outage locations not mapped.	During an actual outage some data is recorded on duration.	Outage locational data is broad and refers to total number customers within a county.
Multi-Structure Fire	May take place anywhere in the county.	Data not formally collated across agencies.	Data not formally collated across agencies.
Major Transportation Incident	Depending upon type of incident, could occur anyplace in the county.	No formal database of damages.	Varies depending upon type of incident.
Water Supply Loss	Water distribution systems are mapped.	Data not formally collated across agencies.	Data not formally collated across agencies.
Sewer Service Loss	Sewer lines are mapped.	Data not formally collated across agencies.	Data not formally collated across agencies.

Hazard	Is Location data available?	Is Extent data available?	Is Impact data available?
Natural Gas Service Loss	General areas of services are known but specific locations of loss not recorded.	Information for this rate occurrence not publicly available.	No formal damage has been documented to date.
Telecommunications Failure	Depending upon type of incident, could happen anywhere.	Information for this rare occurrence not publicly available.	No formal damage has been documented to date.
Other Fuel Service Loss	Known distribution points and addresses.	No formal loss of service has been documented.	No formal damage has been documented to date.

Table 4.5 Summary of Societal Hazards Discussed but Not Fully Profiled in the 2022 MJAHMP

Hazard	Is Location data available?	Is Extent data available?	Is Impact data available?
Societal Hazards			
Crime	Potential exists countywide that an incident could occur.	Data Collection is not standardized across all municipalities.	Significant socioeconomic impacts.
Civil Disturbance	Significant incidents may occur anywhere in the county.	No formal damage has been documented to date.	No formal damage has been documented to date.
Terrorism	The FBI does not share a list of potential targets.	Unknown but assumed to be significant if incident occurs.	Unknown but assumed to be significant if incident occurs.
Economic Recession	Countywide.	Historic data on unemployment levels & poverty rates.	Longer lasting impacts hard to measure below county level
Key Employer Loss	Depending upon type of employer.	No formal database of damages.	No formal database of key employer loss is maintained.

Hazard	Is Location data available?	Is Extent data available?	Is Impact data available?
Epidemic [now Human Infectious Disease]	May occur in a specific community or countywide.	Data was not previously formally collated across agencies; however, the COVID-19 pandemic has clarified agency roles and responsibilities so that detailed information and data is available.	The 2017 noted that no damage had been documented to data; however, with the onset of COVID-19, the hazard has increased significantly in risk and vulnerability. Consequently, its profile was elevated by moving it to the natural hazard section.

Step 3: Hazard Scoring Methodology and Hazard Ranking

To maintain a reporting format consistent with the 2018 SHMP and the 2017 MJAHMP, the AHMPUC used the same methodology to score and rank the hazards. The ranking was based on a scoring system that considers four elements of hazard risk: probability, magnitude/severity, warning time, and duration.

Because quantitative data does not always provide a full picture of hazard impacts, the results of the statistical ranking were discussed with the AHMPUC and with individual jurisdiction planning teams to secure their perspective on how each hazard affects their municipalities. With their input, hazards were ranked as being of Low, Medium, or High concern per jurisdiction. Numerical scores for each category were totaled to obtain an Overall Risk Score, which is summarized as one of these risk and vulnerability classifications. Each jurisdiction was asked to rank the hazards for their respective community. Individual jurisdiction annexes include a detailed jurisdiction-based hazard summary. Additionally, the Chittenden County Regional Planning Commission (CCRPC) provided a regional hazard ranking for the County. (Note: Dam Failure was not assessed.)

Table 4.6: Summary of Jurisdictional Hazard Risk Rankings, by Hazard

Jurisdiction	CCRPC	Bolton	Buels Gore	Burlington	Charlotte	Colchester	Essex	Essex Junction	Hinesburg	Huntington	Jericho	Milton	Richmond	St. George	Shelburne	South Burlington	Underhill	Westford	Williston	Winooski
Natural Hazards																				
Dam/Levee Failure	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Flooding	M	H	L	M	M	M	M	M	M	M	M	M	H	L	M	L	H	M	M	L
Fluvial Erosion	M	H	M	M	M	M	M	M	M	M	M	M	H	L	-	-	-	-	L	L
Human Infectious Disease	H	M	L	M	L	M	M	M	M	M	L	M	M	M	M	M	M	M	M	M

Jurisdiction	CCRPC	Bolton	Buels Gore	Burlington	Charlotte	Colchester	Essex	Essex Junction	Hinesburg	Huntington	Jericho	Milton	Richmond	St. George	Shelburne	South Burlington	Underhill	Westford	Williston	Winooski
Invasive Species	M	M	L	L	M	M	M	L	M	L	L	L	L	L	L	L	L	L	L	L
Severe Rainstorm	H	H	M	H	M	M	M	M	H	M	M	H	L	H	H	H	H	M	H	H
Severe Winter Storm	H	H	H	H	H	H	H	H	H	H	H	H	H	H	M	M	H	H	H	H
Wildfire	L	M	L	L	L	L	L	L	L	L	L	L	L	M	M	L	M	L	L	L
Technological Hazards																				
Hazardous Materials	M	L	L	H	L	L	M	M	L	L	L	M	L	L	M	M	L	L	H	M
Major Transportation Incident	M	M	M	M	M	M	M	M	L	L	L	M	H	L	M	M	L	L	M	M
Multi-Structural Fire	M	L	L	H	M	L	M	M	M	M	L	M	L	M	M	M	M	L	M	M
Natural Gas Service Loss	L	L	L	L	L	L	L	L	L	M	L	L	L	L	M	L	L	L	L	L
Other Fuel Service Loss	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	L
Power Service Loss	M	H	L	L	M	M	M	M	M	M	M	M	M	H	L	L	H	L	L	H
Sewer Service Loss	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	M	L	L	M	M
Telecommunications Failure	L	M	L	L	M	L	M	M	M	M	M	L	L	L	M	L	L	M	M	L
Water Pollution (algal bloom, etc.)	H	L	L	M	M	L	M	M	L	L	L	L	L	L	M	M	L	L	L	L
Water Supply Loss	M	L	L	L	L	L	M	M	L	L	L	L	L	M	M	M	M	L	L	L
Societal Hazards																				
Civil Disturbance	M	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Crime	M	L	L	L	M	M	L	L	L	L	L	M	M	M	L	L	L	M	M	M
Economic Recession	M	L	L	L	M	M	M	M	M	M	M	M	M	L	M	M	M	M	L	M
Key Employer Loss	L	M	L	L	L	L	M	M	L	L	L	M	M	L	L	L	L	L	L	M
Terrorism	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	M	L	L	L	L

Table 4.7: Risk Level Definitions

RISK LEVEL
Low

A hazard with a ***LOW-RISK*** rating is expected to have little to no impact on the jurisdiction. The hazard poses minimal health and safety consequences to the state's residents and is expected to cause little to no property damage. The occurrence of a hazard with a ***LOW-RISK*** rating is rare; however, due to other factors such as geographic location it is still possible for such a hazard to occur and cause even significant damage based upon the magnitude of the event.
Moderate
A hazard with a ***MODERATE RISK*** rating is expected to have a moderate impact on the jurisdiction. The hazard poses minor health and safety consequences with minor injuries expected and few to no fatalities. It may cause some property to be damaged or destroyed. A ***MODERATE RISK*** hazard is likely at least once within the next 25 years.
High
A hazard with a ***HIGH-RISK*** rating is expected to significantly impact upon the jurisdiction. The hazard poses high health and safety consequences with numerous injuries and fatalities possible. The hazard may cause even some property to be damaged or destroyed. A hazard with a ***HIGHRISK*** rating is expected to occur at least once within a 12-month period but may occur multiple times within a year.

General Hazard Information

This section of the Plan provides general information that may be applicable to all hazards having the potential to impact municipalities in Chittenden County. Individual characteristics of specific hazards are further described in the individual hazard profiles that follow this section.

Federal Disaster Declarations

Information used to identify hazards relevant for inclusion in the Chittenden County plan update included a review of hazard events that triggered federal disaster declarations. Federal and/or state declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover from the event, so outside disaster assistance is supplemental and sequential. Sequential means that when the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. If the disaster is so severe that the capacity of both the local and state government is exceeded, a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

Emergency declarations are also issued, which may be limited in scope and do not include the long-term federal recovery programs of major disaster declarations. Determinations for declaration type are based on scale and type of damages and institutions or industrial sectors affected. Six federal major or emergency declarations have been awarded since the 2017 *MJAHMP* plan was produced.

Table 4.8: Federal Disaster Declarations in Chittenden County (1973 - 2021)[23]

Disaster Number	Event Type	Declaration Date	Type of Assistance
EM-3567-VT	*Tropical Storm Henri*	8/22/2021	PA (Cat. B)
DR-4532-VT	*COVID-19 Pandemic*	4/8/2020	IA, PA (Cat. B)
DR-4474-VT	*Severe Storm and Flooding*	1/1/2020	PA (Cat. A-G)
EM-3437-VT	*COVID-19*	3/13/2020	PA (Cat B)
DR-4380-VT	*Severe Storm and Flooding*	7/30/2018	PA (Cat. A-G), HMGP
DR-4356-VT	*Severe Storm and Flooding*	1/2/2018	PA (Cat. A-G)
DR-4207-VT	*Severe Winter Storm*	2/3/2015	PA (Cat. A-G)
DR-4232-VT	*Severe Storm and Flooding*	7/29/2015	PA HMGP
DR-4163-VT	*Severe Winter Storms*	1/29/2014	PA (Cat. A-G)
DR-4140-VT	*Severe Storms and Flooding*	8/2/2013	PA
DR-4022-VT	*Tropical Storm Irene*	9/1/2011	IA, PA
DR-1995-VT	*Severe Storm and Flooding*	6/15/2011	IA, PA
EM-3338-VT	*Hurricane Irene*	8/29/2011	PA (Cat B)
DR-1951-VT	*Severe Storm*	12/22/2010	PA (Cat. A-G)
DR-1559-VT	*Severe Storm and Flooding*	9/23/2004	PA
EM-3167[24]	*Snowstorm*	4/10/2001	PA (Cat. B)
DR-1228-VT	*Severe Storm and Flooding*	6/30/1998	IA, PA
DR-1201-VT	*Severe Ice Storms,*	1/15/1998	IA, PA
DR-1201-VT	*Rain, High Winds and Flooding*	1/15/1998	-
DR-1101-VT	*Severe Storm and Flooding*	2/13/1996	PA
DR-4140-VT	*Severe Storm and Flooding*	8/2/2013	PA (Cat. A-G)
DR-4120-VT	*Severe Storm and Flooding*	6/13/2013	PA (Cat. A-G)
DR-1063-VT	*Heavy Rain, Flooding*	4/16/1995	IA, PA
DR-990-VT	*Flooding, Heavy Rain, Snowmelt*	5/12/1993	IA, PA
DR-938-VT	*Flooding, Heavy Rain, Ice Jams*	3/18/1992	IA, PA
DR-875-VT	*Flooding, Severe Storm*	7/25/1990	IA, PA
DR-518-VT	*Severe Storms, High Winds, Flooding*	8/5/1976	IA, PA
DR-397-VT	*Severe Storms, Flooding, Landslides*	7/6/1973	IA, PA

Note: NCEI's first entries in the Storm Events Data base are from 1950 but the earliest entry for Chittenden County is from 1973.

[1] Federal Emergency Management Agency (FEMA), Declared Disasters, Accessed 6/15/2021

[2] EM-3167-VT was declared for a snowstorm leading to snow melt and associated runoff due to the spring melt that resulted in lakeshore **flooding** on Lake Champlain continuing into May 2001.

Additional Hazard Risk Considerations

National Risk Index (Chittenden County numbers)

The National Risk Index (NRI) is a dataset and online tool developed by the Federal Emergency Management Agency (FEMA) and other partners to help identify communities in the United States at risk for 18 natural hazards. Hazard risk is calculated on data for a single hazard type and reflects the relative risk for that hazard type and should be considered only as a baseline relative risk measurement for the purpose of a general comparison with the local hazard risk ranking in this section.

NRI calculations do not follow the same criteria and formulas used in the hazard risk ranking methodology for this plan but are provided as a comparative measurement of risk. In addition, some hazards are defined differently from hazards in this plan, so a direct hazard-to-hazard comparison of risk is not able to be determined.

Based on the NRI findings (in scoring order) for Chittenden County, winter weather, ice storms, and cold waves are the three highest risk hazards for the county, although they are all determined to be “relatively low”. Riverine flooding and earthquake are also determined to be relatively low risk hazards, with scores significantly lower than the highest three hazards. Drought is not rated; however, all other hazards are identified as “very low” risk.

Hazard Type	Risk Index Rating	Risk Index Score
Avalanche	Not Applicable	--
Coastal Flooding	Not Applicable	--
Cold Wave	Relatively Low	9.74
Drought	No Rating	0.00
Earthquake	Relatively Low	3.86
Hail	Very Low	4.18
Heat Wave	No Rating	0.00
Hurricane	Very Low	3.16
Ice Storm	Relatively Low	10.41
Landslide	Very Low	6.72
Lightning	Very Low	7.56
Riverine Flooding	Relatively Low	5.92
Strong Wind	Very Low	6.79
Tornado	Very Low	4.08
Tsunami	Not Applicable	--
Volcanic Activity	Not Applicable	--
Wildfire	Very Low	1.45
Winter Weather	Relatively Low	11.49

Figure 4.1: Summary of National Risk Index Findings, Chittenden County[25]

The NRI rating for Risk, Expected Annual Loss, and Social Vulnerability is Very Low for Chittenden County, VT when compared to the rest of the United States. Just over nine percent

[25] Community Report - Chittenden County, Vermont | National Risk Index (fema.gov)

[4] FEMA, National Risk Index (NRI), retrieved at: https://hazards.fema.gov/nri/

(9.2%) of U.S. counties have a lower Risk Index. One fifth of Vermont counties (21.4%) have a lower Risk Index.[4]

Table 4.9: Comparison of Chittenden County's National Risk Index Findings Scores with Vermont and National Average[26]

Index	Rank	Chittenden County	Vermont Average	National Average
Risk	Very Low	4.74	5.73	10.60
Expected Annual Loss	Very Low	10.14	8.46	13.33
Social Vulnerability	Very Low	23.33	33.35	38.35

Step 4: Developing Hazard Profiles

Profiles of each hazard addressed in this plan are presented in **Sections 4.1 to 4.9** and incorporate specific elements that must be included per the requirements of the FEMA Local Hazard Mitigation Plan (LHMP) Review Tool. State and FEMA Plan reviewers will measure the 2022 update against Review Tool criteria.

Table 4.10: Summary of Hazard Profile Elements

Hazard Profile Element	Description
Hazard Definition and Characteristics	The hazard is defined and/or described in relation to its general characteristics, including types and key terms.
Location	In general, all of Chittenden County is susceptible to most natural meteorological hazards, such as severe winter weather, flood, and severe rainstorms. Other types of hazards, such as human infectious disease and plant disease and pests may have more localized areas of impact. Potential impact areas for each hazard profiled in this plan are described in the specific hazard sections.
Extent	Extent considers measures of magnitude, such as scientific scales, water depth, speed of onset or duration of event. For most hazards, the longer the duration, the greater the extent of impact.
Previous Occurrences	Information on historical occurrences, including federally declared disasters and the impacts of the loss of life, injuries, and damages are described in the sub-section.
Probability of Future Events and Impacts of Climate Change	Discussion of the likelihood of the hazard occurring in the future and changes in hazard trends and patterns. There is some challenge in using statistics to document past natural hazard events due to the difference in hazard definitions, how incidents are reported, and the type of database that produces analysis of these events. For the purpose of this plan, the National Center for Environmental Information (NCEI), Storm Events Database (NOAA) serves as the primary data source for documenting previous weather occurrences and calculating future probability, where sufficient data is available. In addition, probability calculations produced by the National Risk Index were included in the discussions for the three highest hazards of concern, Flooding, Severe Rainstorm and Severe Winter Storm.

[26] Community Report - Chittenden County, Vermont | National Risk Index (fema.gov)

Hazard Profile Element	Description
Jurisdictional Vulnerability and Potential Losses	Discussion on the vulnerability of the county's population and local assets, including critical infrastructure and related estimated potential losses is provided, including specific local assets at risk.
Future Population and Development Trends	Discussion on the impact of development in hazard prone areas throughout the County related to each hazard.
Factors for Consideration in the Next Planning Cycle	Describes specific points to consider in relation to each hazard when conducting plan maintenance for monitoring, evaluation, and update of the plan.

Population Vulnerability

Chittenden County residents may be at risk based on proximity to hazard-prone areas. Also, hazards such as severe rainstorms, severe winter storms, and tornadoes may affect residents if accompanied by high winds, hail or lightning. Information about specific at-risk populations is addressed in each hazard section. Vulnerable populations are more susceptible to the impacts of disasters and may experience more long-term effects with a loss of their social support networks. Other residents may be considered vulnerable due to their everyday living conditions. There are multiple methodologies and tools available to identify and measure the extent of vulnerability to some of these populations in relation to hazards. The Plan update includes the 2018 Centers for Disease Control and Prevention (CDC), Social Vulnerability Index (SVI), which provides a quantifiable ranking to indicate potential levels of vulnerability when disasters impact a jurisdiction. The SVI uses themed maps to identify four community characteristics: Household Composition/Disability; Socioeconomic Status, Housing Type/Transportation; and Race/Ethnicity/Language. Themed maps show areas of higher vulnerability where extra outreach efforts in alternate formats and languages may be needed.[27]

[27] Centers for Disease Control and Prevention (CDC), Agency for Toxic Substances and Disease Registry, CDC Social Vulnerability Index 2018, Chittenden County, VT, Accessed 7/31/2021.

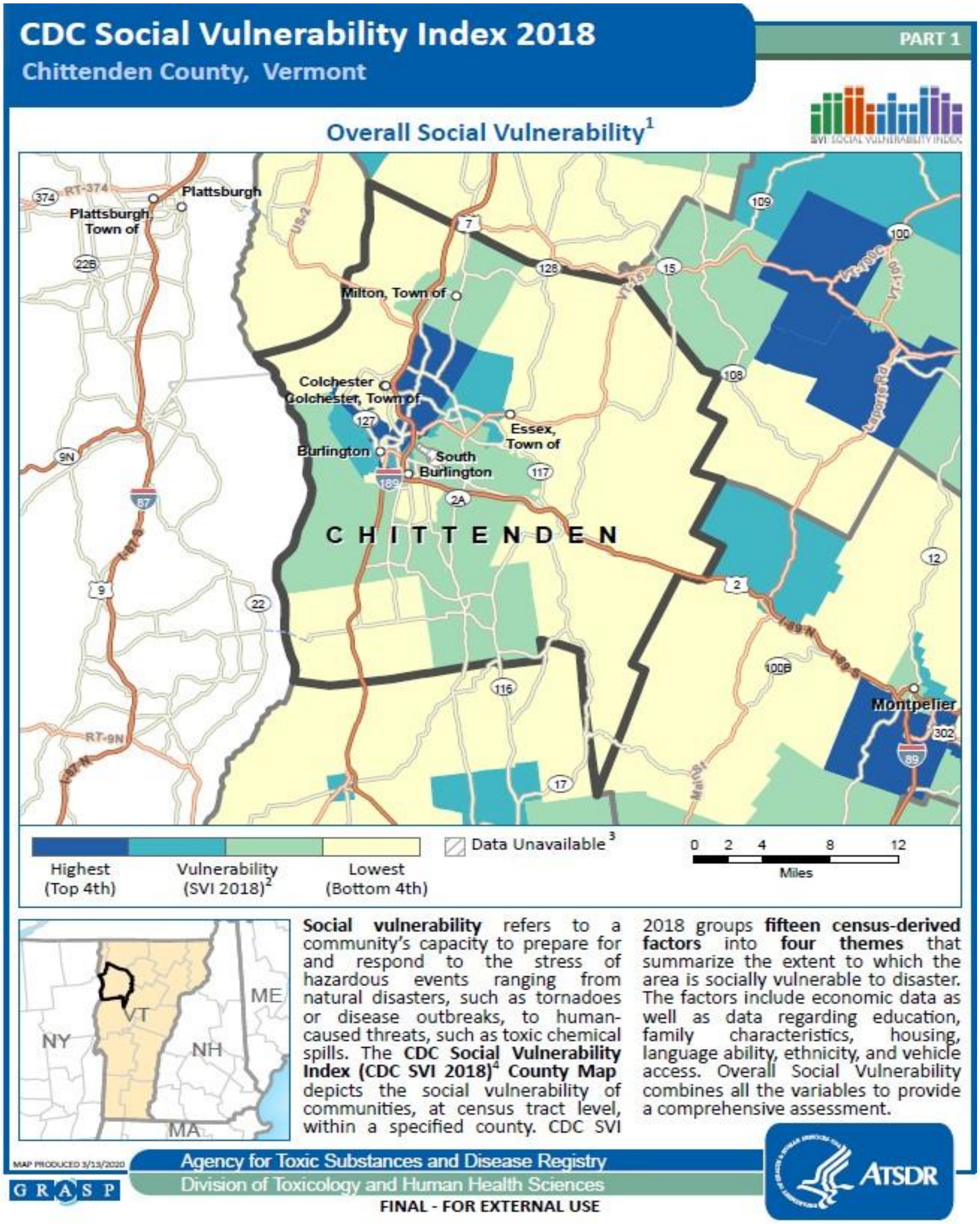


Figure 4.2: Overall Social Vulnerability Map, Chittenden County, Vermont (2018)[28]

[28] Centers for Disease Control and Prevention, Social Vulnerability Index, 2018.

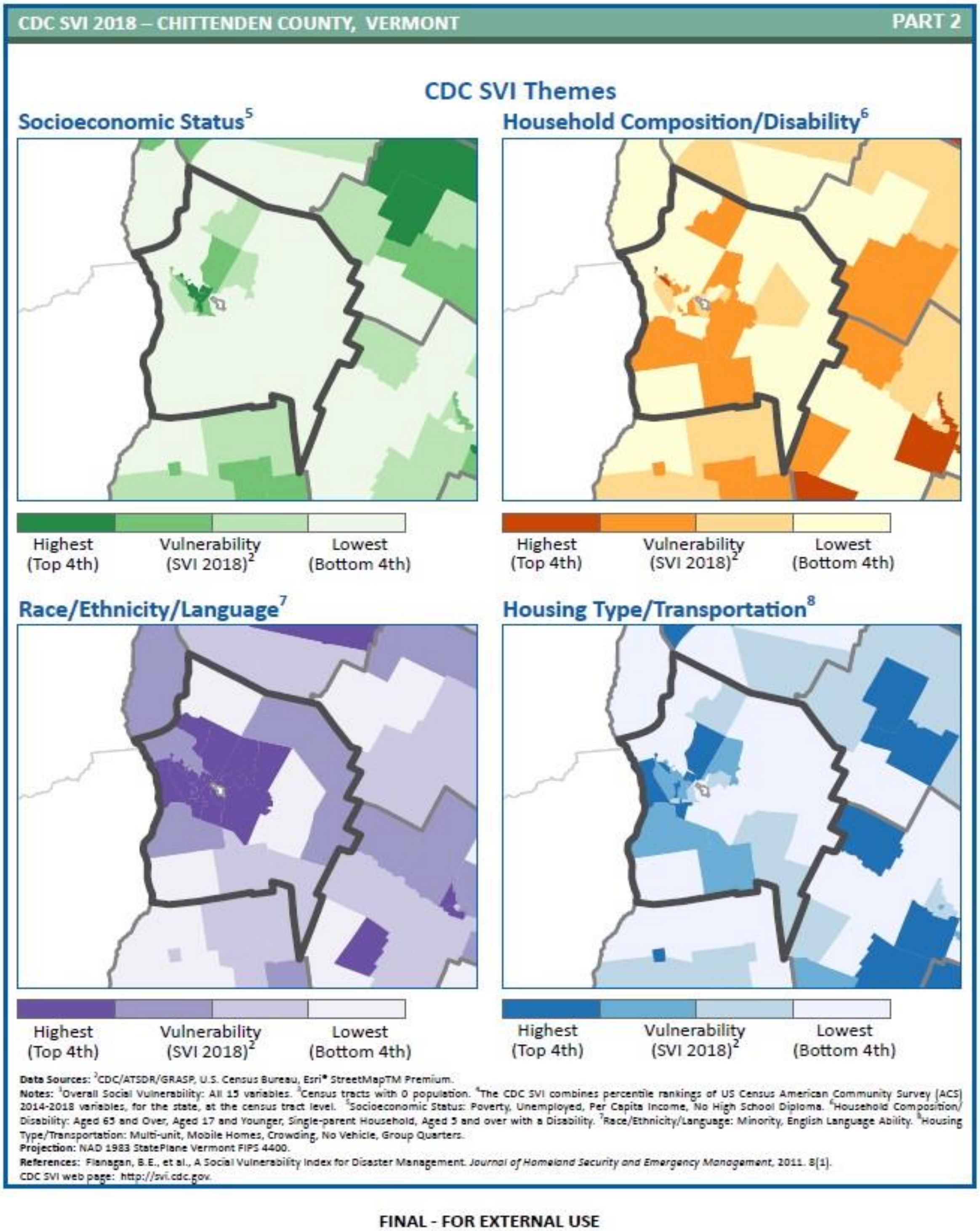


Figure 4.3 Social Vulnerability Theme Maps, Chittenden County[29]

---

[29] [Community Report - Chittenden County, Vermont | National Risk Index (fema.gov)]

Natural Hazards and Climate Change

In accordance with FEMA Administrative Policy 2011-OPPA-01, this plan update, to the degree possible, considers the potential impacts of climate change in relation to the hazards profiled. On November 9, 2021, the University of Vermont (UVM) Gund Institute for the Environment released a comprehensive study of climate change, the *Vermont Climate Change Study*.[30] The Institute partnered with The Nature Conservancy, the Vermont Department of Forests, Parks and Recreation, the Vermont Natural Resources Council, and the Norman Foundation to develop the study and was assisted by many other climate professionals and organizations studying climate change.[31]

Among other findings, the study reports that the state's average annual temperature has warmed by nearly 2 degrees Fahrenheit, and precipitation has increased by 21 percent, since 1900.

The study included use of the latest climate science to investigate the effects of climate change impacts across ten key sectors of Vermont society. These included health, water, food and agriculture, energy, transportation, forests, tourism and recreation, fish and wildlife, and others. The full report is available online at www.vtclimate.org, but a summary of key findings is presented here.

Table 4.11: Key Findings of the Vermont Climate Assessment 2021[32]

Key Finding	Description
Temperature	Vermont is warming—especially winters. Average temperatures have increased by nearly 2°F since 1900. Winter temperatures have increased 2.5 times faster than average annual temperatures since 1960. Vermont's freeze-free period has lengthened by three weeks since 1960. On average, lakes and ponds are thawing one to three days earlier per decade.
Precipitation	Vermont is becoming wetter. Precipitation has increased 21 percent since 1900. Vermont now experiences 2.4 more days of heavy precipitation than in the 1960s, mostly in the summer. With flooding expected to increase, improved stormwater infrastructure and planning is required to reduce damage to homes, roads, bridges, and farm fields. Heavier rainstorms will impact farm and forestry operations.

[30] Basil Waugh, University of Vermont Gund Institute for the Environment, Vermont Climate Assessment: Climate Change is here. Retrieved at: https://www.uvm.edu/news/gund/Vermont-getting-warmer-andwetter-climate-change-study, Accessed 01/12/2012.
[31] University of Vermont Gund Institute for the Environment, Vermont Climate Assessment: About the Climate Assessment, https://www. site.uvm.edu/vtclimateassessment/about-vca. Accessed 01/12/2021.
[32] Ibid.

Key Finding	Description
Floods and Droughts	Floods and droughts are now Vermont's most likely natural disasters. Both are expected to increase due to growing variability of rain and changing water tables. As a result, irrigation infrastructure will remain crucial for farms and gardens.
Wildlife	Roughly 70 bird species are expected to disappear from Vermont in the next 25 years due to climate change, including the common loon and hermit thrush. Moose numbers are projected to decline, and white-tailed deer populations are expected to increase.
Forests and Lakes	Climate change is making conditions less favorable for several Vermont tree species-including the iconic sugar maple-and exacerbating threats (invasive plants, insects, diseases) to forests. Warming waters will have adverse effects on lakes and rivers, including increased risk of harmful algal blooms and reduced biodiversity.
Recreation	The Vermont ski season will be shortened by one month (under a high emissions scenario) or by two weeks (under a low emissions scenario) by 2080. With snowmaking, the downhill skiing sector can likely remain viable in Vermont up until approximately 2050. In the summer, increased risk of harmful algal blooms will impact beaches, swimming, and other lake activities.
Tourism	Vermont's warming climate will remain attractive compared to many regions. Expect an increase in summer "seasonal climate refugees" as rising temperatures nationwide draws visitors looking to escape extreme heat. As summers-and growing seasons-lengthen, Vermont has the potential to increase tourism revenue via agritourism and gastrotourism.
Agriculture	Rising temperatures and longer growing periods may benefit some farmers and make new crops feasible. However, increasing precipitation and variability will complicate growing conditions for many crops, including apples and maple syrup, increasing the likelihood of crop damage or crop failure.
Emissions	Transportation is the largest source of greenhouse gas emissions, and Vermonters drive the highest average miles per capita in the Northeast. Thermal energy for heating buildings is a close second major source of greenhouse emissions.
Energy	Heating uses the largest amount of energy in Vermont, followed by transportation. Electrifying these two sectors as much as possible will significantly reduce Vermont's carbon footprint. Electricity in the state has the lowest carbon intensity in the country.
Health	Climate-related health impacts include greater risk of health exposure, diseases from ticks and mosquitoes, water quality issues, and natural disasters. These threaten some populations more than others, highlighting the unequal burden of climate impacts of people who are over 65, from marginalized communities, or have previous health issues.

The 2021 Climate Change Assessment is a valuable tool not only for pointing out the harmful trends in each area covered under Key Findings. The report also discusses a range of mitigation measures that may be appropriate to a community's hazards and vulnerabilities.[33]

[33] Waugh

Project researchers also note, in order to address the growing risk of floods and droughts, communities will require greater planning and investment in infrastructure for managing water, stormwater and irrigation. Planning is crucial to prepare for current and future climate change impacts, and for accessing federal funding.

Development Trends)

The vulnerability of future buildings, infrastructure, and critical facilities is a great concern to community leaders across the County and, as discussed in the Capability Assessment section, many of the day-to-day activities in local governments in the County are designed to deal with these challenges.

Zoning is also a critical indicator to review in considering local development trends.

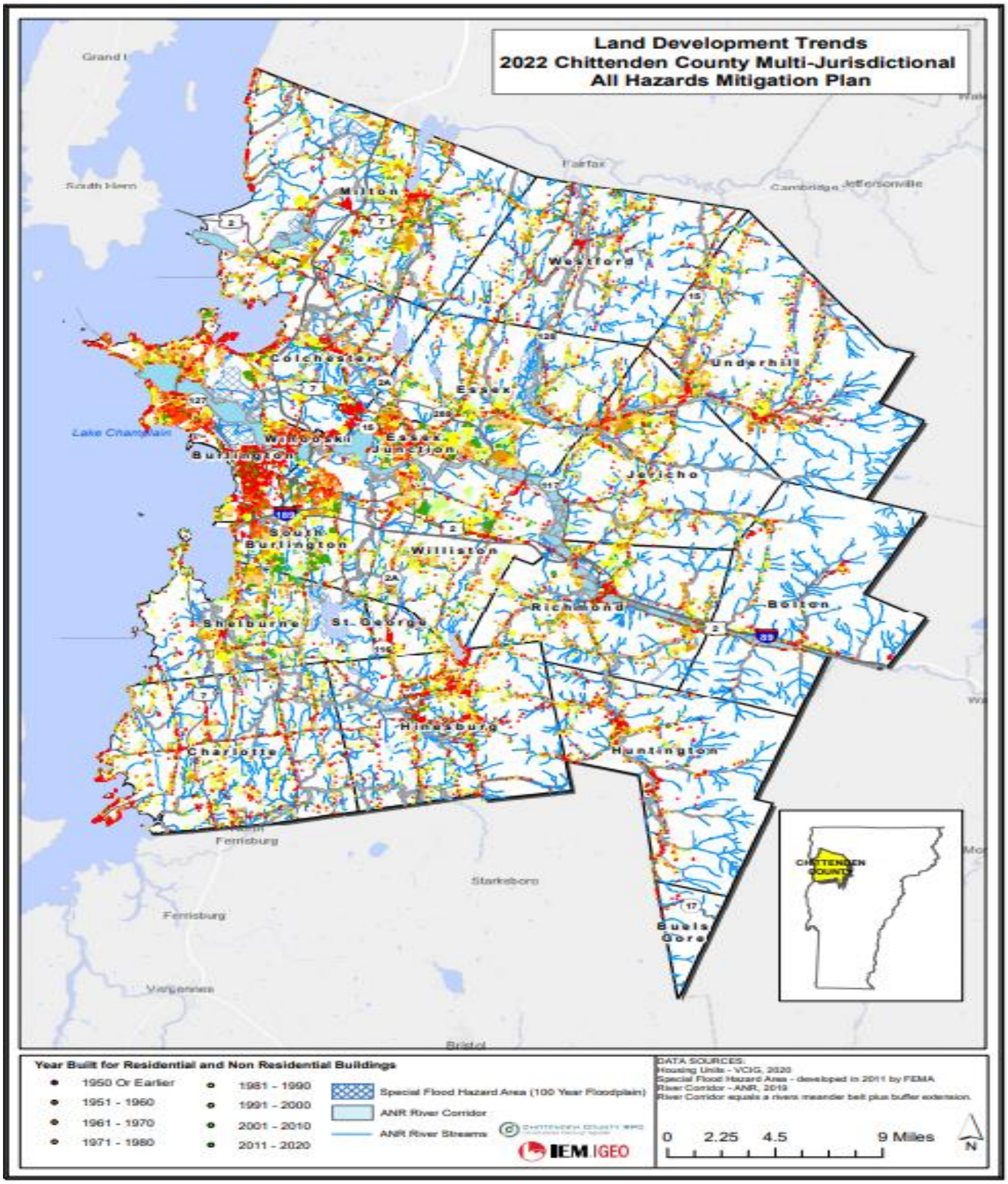

Land Development Trends
2022 Chittenden County Multi-Jurisdictional
All Hazards Mitigation Plan
Milton
Westford
Colchester
Underhill
Essex
Winooski
Essex Junction
Burlington
Jericho
South Burlington
Williston
Richmond
Bolton
Shelburne
St. George
Hinesburg
Charlotte
Huntington
Buels Gore
Lake Champlain
Year Built for Residential and Non Residential Buildings
1950 Or Earlier
1951 - 1960
1961 - 1970
1971 - 1980
1981 - 1990
1991 - 2000
2001 - 2010
2011 - 2020
Special Flood Hazard Area (100 Year Floodplain)
ANR River Corridor
ANR River Streams
DATA SOURCES:
Housing Units - VCGI, 2020
Special Flood Hazard Area - developed in 2011 by FEMA
River Corridor - ANR, 2019
River Corridor equals a rivers meander belt plus buffer extension.
0 2.25 4.5 9 Miles

Figure 4.4. Land Development Trends[34]

Table 4.12: Land Use Compared to Zoning (by acres), Chittenden County[35]

Institutional	Mass Leisure	Natural	Dwelling	Com/Ind	Commercial	Industrial	Infrastructure	Assembly	Recreation Resources Units Area (ft^2	Com/Ind Total Area (acres)
Center	2,234	969	39	170	46	6	0	12,443	7,155,889	164.28
Enterprise	182	750	155	62	4	1	6	266	13,237,550	303.89
Metro	18,547	915	127	203	58	35	3	31,493	16,559,571	380.16
Rural	14,736	219	129	148	46	83	187	16,684	754,385	17.32
Suburban	12,618	196	64	51	37	22	6	12,813	1,666,259	38.25
Village	4,870	388	37	85	97	9	6	5,902	1,784,825	40.973
Total:	53,187	3,437	561	719	288	161	208	79,601	41,339,661	949.03
Data used – 2021 e911 site data was used to calculate Residential, Commercial, Industrial, Inst/Infra, Mass Assembly, Leisure/Rec and Natural Resources numbers. Dwelling Units info from CCRPC's 2020 Housing Database. Com/Ind area from CCRPC's 2020 commercial/Industrial database.										

Projected Development

For 2022 and beyond, new construction within the Special Flood Hazard Area (SFHA) is anticipated to be very slight to nonexistent. Fifteen of the County's 19 municipalities do not permit the addition of new structures at all; one community (Buel's Gore) includes no SFHAs and three additional communities (Burlington, Huntington and Underhill) do allow some new structures in the floodplain but only as a conditional use.

Additionally, it is anticipated that some level of new units will be constructed within the River Corridor (RC) because, in some cases, the Corridor exceeds the area not covered by municipal water quality setbacks. Notably, in recent years the City of South Burlington and the Town of Saint George have adopted the state-recommended River Corridor Model Bylaw. The CCRPC anticipates that additional municipalities will adopt such River Corridor protections, to effect strong hazard mitigation as well as to obtain a higher State match of Emergency Relief and Assistance Funds (ERAF) and preclude future development in riverine areas not covered by their own municipal water quality setbacks.

34 Chittenden County Regional Planning Commission, October 2021
35 Ibid.

Table 4.13: Housing Unit Growth and Development, 2010 - 2020[36]

Planning Area	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Center	61	108	36	64	105	204	291	184	136	269	3
Metro	36	27	383	246	199	109	444	327	237	291	263
Suburban	72	83	145	69	98	139	122	96	120	74	109
Village	22	38	17	22	104	42	55	29	31	56	44
Rural	71	78	64	66	107	93	100	93	109	86	89
Enterprise	1	0	0	1	0	0	1	1	0	0	0
Total	263	334	645	468	613	587	1013	730	633	776	508

Transportation Infrastructure

Many people desire urban or suburban housing to live close to work, school and shopping. However, a significant number of people also desire more rural locations. Complicating matters is the high cost of housing, due to a shortage of both rental units and/or single-family homes in the county. This has forced many people to live in the county's outlying municipalities or even outside the county itself. A growth pattern of this nature necessitates a transportation system that supports people's mobility and a utility system that allows a certain standard of living to which people have become accustomed. Unfortunately, transportation and utility systems are vulnerable to natural disasters and any interruption is likely to have adverse effects on the health and safety of people in Chittenden County.

Flooding, fluvial erosion (including landslide) and severe rainstorm damage to roads and culverts is now more common as new access roads, driveways and subdivision roads are built in both steeper and more rural terrain and formerly quiet country roads become commuter routes. Stormwater management has become a growing concern in the county in recent years not only due to these damages but also due to non-point pollution runoff that has degraded water quality and habitat in several small streams in the county's urban and suburban areas. Nine of the County's municipalities are subject to Municipal Separate Storm Sewer System permits issued by the Vermont Department of Environmental Conservation (DEC). Additionally, with the passage of the Vermont Clean Water Act in 2015 and its attendant requirement for implementation of Municipal Roads General Permit, the remaining municipalities in the county (with the exception of Buel's Gore) have had to begin a systematic implementation of various projects to mitigate erosion and stormwater flow off roads.

Transportation infrastructure, not homes and businesses, are the most commonly threatened and damaged property in the County. This is especially true when it comes to unpaved roads. In general, the outlying and higher elevation municipalities have the highest percentages, but even some of the more rapidly developing mixed rural/suburban municipalities have significant amounts of unpaved roads.

[36] Ibid.

The Vermont Agency of Transportation (VTrans) divides municipal (town) highways into various classes:

- Class 1 town highways are state highways in which a municipality has assumed responsibility for most of the day-to-day maintenance (pothole patching, crack filling, etc.). The state is still responsible for scheduled surface maintenance or resurfacing. In Chittenden County Class 1 highways are generally paved.

- Class 2 town highways are primarily the responsibility of the municipality. The state is responsible for center line pavement markings if the municipality notifies VTrans of the need. The municipality designates highways as Class 2 with approval from VTrans. These are, generally speaking, the busier roads in each town second to Class 1. In Chittenden County, most Class 2 highways are generally paved although in the more isolated areas these are gravel roads.

- Class 3 town highways are the responsibility of and designated by the municipality. These are to be maintained to an acceptable standard and open to travel during all seasons. In Chittenden County, Class 3 roads are both paved or gravel.

- Class 4 town highways are owned by the municipality but are not maintained by the town or state. They are generally closed during the winter and minimally maintained and almost exclusively dirt.

Table 4.14: Municipal Highway Paved and Unpaved Road Mileage: Chittenden County[37]

Class 1	Class 2	Class 3	Class 4	Federal Highway & Interstate	State Highway	Total Class 1, 2, 3 & Highway
16.409	287.53	719.85	37.83	N/A	174.506	1198.295
Highway Paved and Unpaved Road Milage						
Paved	Gravel	Soil/Graded	Unimproved	Impassable	Unknown	Total
906	262	46	7	15	N/A	1,236
Total Known	Total Paved	% Paved	% Unpaved			
1236	330	78%	22%			

From a damage mitigation standpoint, the county is fortunate that most of its municipalities' roadways are paved (78%) and very little (22%) is soil/graded or unimproved. While over 50 percent of the roads in Hinesburg (53.7%), Huntington (73.9%), Underhill (67.7%), Westford (76.6%), and Williston (87.6%) are listed as unpaved.

[37] Source: Publications | Agency of Transportation (vermont.gov)

Table 4.15: Municipal highway paved and unpaved road mileage by Jurisdiction, Chittenden County[38]

Jurisdiction	Unpaved	% Unpaved	Paved	% Paved	Total Known
Bolton	11	34.4%	21	65.6%	32
Buels Gore	-	-	3	100%	3
Burlington	1		95		95
Charlotte	34	42%	47	58%	81
Colchester	14	12%	103	88%	117
Essex	25	43.8	32	56.1	57
Essex Junction	1	2.2%	45	98.8%	46
Hinesburg	36	53.7	30	44.8	67
Huntington	34	73.9%	12%	26.1	46
Jericho	33/2		30/7		63/9
Milton	17/1		81/27		97/28
Richmond	25	38.5%	40	61.5%	65
St. George	1	16.7	4	66.7	6
Shelburne	2	3.4%	57	96.4%	59
South Burlington	1	2%	98	98%	100
Underhill	44	68.7%	20	31.3%	64
Westford	38	76%	12	24%	50
Williston	85	87.6%	12	12.4%	97
Winooski	-	-	19	11%	19

As noted in the 2017 Plan, some of the highest damage totals previously suffered in the county were to gravel and dirt roads and culverts due to the inability of this type of infrastructure to handle large volumes of snowmelt, stormwater runoff, rising stream waters, or the sediment and debris that comes with them. More urban municipalities, by contrast, suffered only minor damage from such flooding. However, it would be simplistic to argue that paving gravel roads in the outlying municipalities by itself would adequately mitigate against the effects of future flooding. Paving programs must also be combined with systematic upgrading of culverts and other measures to adequately handle excessive water volumes. In some cases, upgrading gravel road construction, culverts, and drainage may be preferable to paving.

[38] Ibid.

NATURAL HAZARD PROFILES

SECTION 4.1 DAM FAILURE

2022 P Update
• Enhanced and reformatted the Dam Failure profile to include consideration of requirements for High Hazard Potential Dam (HHPD) Grant Program • Confirmed the number of dams in the planning area and the classification levels identified by the U.S. Army Corps of Engineer's (USACE) National Inventory of Dams (NID), Vermont Agency of Natural Resources (ANR), and Vermont Department of Environmental Conservation (DEC), Dam Safety Program • Updated data sources • Added factors for consideration in the next planning cycle

Dam Failure					Overall Vulnerability
Definition, Key Terms, and Overview					**[Unranked][39]**
A **Dam** is an artificial barrier capable of impounding water, sediment, or other liquid. This includes structures that have been partially removed, partially breach, or were previously capable of impounding water.[40] **Dam Failure** is a catastrophic type of failure characterized by the sudden, rapid, uncontrolled release of impounded water or the likelihood of such an uncontrolled release. A systematic failure of the dam structure resulting in the uncontrolled release of water can result in flooding that exceeds the 100-year floodplain boundaries.					
Frequency	Probability	Potential Magnitude			
		Injuries/Deaths	Infrastructure	Environment	
[Unranked]	[Unranked]	[Unranked]	[Unranked]	[Unranked]	

4.1.1 HAZARD PROFILE

Worldwide interest in dam and levee safety has risen significantly in recent years. Aging infrastructure, new hydrologic information, and population growth in floodplain areas downstream from dams and near levees have resulted in an increased emphasis on safety, operation, and maintenance. The distinction between dams and levees is their purpose: dams are constructed to impound water behind them, and levees are constructed to keep water out of the land behind them.

There are about 91,000 dams in the United States today[41], the majority of which are privately owned. Public owners include state and local authorities, and federal agencies. Benefits provided by dams include water supplies for drinking, irrigation, and industrial uses; flood control; hydroelectric power; recreation; and navigation.

[39] Due to minimal data and information related to previous occurrences and extent, Dam Failure was not ranked by the jurisdictions for hazard risk for this Plan update, but will be included in the all-hazards ranking in the next Plan update.
[40] Vermont Department of Environmental Conservation, Dam Safety Program. Retrieved at: https://dec.vermont.gov/water-investment/dam-safety
[41] National Inventory of Dams, 2018.

A primary cause of dam failure includes overtopping (occurring in approximately 34 percent of all dam failures in the United States) caused by water spilling over the top of the dam, frequently due to inadequate spillway design or debris blockage of spillways; foundation failure; piping (water escaping through narrow channels under the dam); or poor maintenance. Related conditions leading to dam failure include:

- Prolonged periods of rainfall and flooding, which cause most failures
- Inadequate spillway capacity, resulting in excess overtopping of the embankment
- Internal erosion caused by embankment or foundation leakage or piping
- Improper maintenance, including failure to remove trees, repair internal seepage problems, or maintain gates, valves, and other operational components
- Improper design or use of improper construction materials
- Failure of upstream dams in the same drainage basin
- Landslides into reservoirs, which cause surges that result in overtopping
- High winds, which can cause significant wave action and result in substantial erosion
- Destructive acts of terrorism
- Earthquakes, which typically cause longitudinal cracks at the tops of the embankments, leading to structural failure

Dam failure may also be triggered by an earthquake that occurs within or outside of the planning area. While 19 instances of dam failure in Vermont have been reported since 2000, none of these were identified as being related to an earthquake event impacting the planning area.

When dam failure occurs, the energy of the water stored behind the dam can cause rapid and unexpected flooding downstream, resulting in loss of life and major property damage. A devastating effect on water supply and power generation could be expected as well, if the water contained behind the dam serves one of those purposes. The terrorist attacks of September 11, 2001 generated increased focus on protecting the country's water infrastructure, including ensuring the safety of dams.

In Vermont, dams are regulated by four distinct entities depending on the purpose and owner of the dam[42]:

- Dams that are part of the production of power (i.e., hydropower) constructed before 1935 (with a few exceptions) are regulated by the State of Vermont Public Utility Commission (PUC). The PUC regulates approximately 25 dams, six are considered High hazard and five are considered Significant hazard.
- Hydropower Dams constructed after 1935 (with a few exceptions) are regulated by the Federal Energy Regulatory Commission (FERC). FERC regulates approximately 80 dams, 18 are considered High hazard and seven are considered Significant hazard.
- Dams owned by the Federal Government (i.e., United States Army Corps of Engineers) are essentially self-regulated by that agency. Federal entities regulate approximately five

[42] 2018 Vermont State Hazard Mitigation Plan, p. 59.

High hazard dams and one Significant Hazard dam in Vermont.
- Non-federal, non-power dams are regulated by the Vermont Department of Environmental Conservation, (DEC). The DEC regulates approximately 41 High Hazard Dams and 110 Significant hazard dams in the state and a total of 14 state-owned dams in Chittenden County.

This section does not address levee failure or the following structures which are not considered as dams under Vermont law, as they are not considered a significant hazard in Chittenden County:

- Transportation infrastructure that impounds water only during storm events
- Stormwater management structures – regulated by the Vermont Agency of Natural Resources (ANR) under 10 V.S.A. Chapter 47
- Underground or elevated tanks regulated by ANR
- Agricultural waste storage facilities – regulated by the Agency of Agriculture, Food, and Markets under 6 V.S.A. Chapter 215
- Beaver dams

Because dams represent a risk to public safety, they require ongoing maintenance, monitoring, safety inspections, and sometimes rehabilitation to continue safe service.

Dams are classified according to their potential for impact to the population or property.

- *High* – Dams that upon failure would cause probable loss of life or serious economic damage.
- *Significant* – Dams that upon failure might cause loss of life or appreciable economic damage.
- *Low* – Dams that upon failure would lead to no expected loss of life or significant economic damage. Special criteria: This classification includes dams that upon failure would cause damage only to the property of the dam owner.

Table 4.1.1: Hazard Profile Summary for Dam Failure

DAM FAILURE Assessment: [Unranked]	**Location**	Specific local locations	***Potential Cascading Effects***
	Extent	Low to Moderate	• Rapid unexpected flooding downstream, resulting in loss of life and property damage • Devastating effects on water supply and power generation • Damage to homes, businesses, environmental assets,
	Duration	Several minutes to several days	
	Probability	Low	
	Seasonal Pattern	No Seasonal pattern	
	Speed of Onset	There may be a sudden failure or one may occur slowly if there is infrastructure deterioration that goes unnoticed or regular assessments are not conducted	

	Warning Time	Warning time can be minutes or hours	and persons living in the flood inundation zone
	Repetitive Loss	Potentially, if there are previously damaged structures in the inundation area	

Location

There is some discrepancy between national and state records documenting the number of dams and their classification in the planning area, primarily due to the difference in reporting requirements related to maximum storage volume for various dam regulatory agencies. The *2017 Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan (MJAHMP)* noted that the Vermont ANR Dam Safety Program maintains an inventory of 1,240 dams (including 90 ANR-owned dams) with impoundments greater than 500,000 cubic feet"[43], which included forty-one dams in Chittenden County. The plan also noted that, although no failures have occurred at these dams, failure of any of these dams could result in significant downstream flooding.

The United States Army Corps of Engineers (USACE), National Inventory of Dams (NID) shows that there are a total of **14 dams** in Chittenden County, with **three classified as High hazard potential dams and five classified as Significant**[44].

The hazard risk assessment in this section is based on the NID data.

Table 4.1.2: High and Significant Hazard Potential Dams in Chittenden County[45]

Dam Name	Ownership Authority	Purpose	Classification
Clark Falls Dam	Green Mountain Power Corporation	Hydroelectric	High
Colchester Pond	Winooski Valley Park District	Recreation	Significant
Essex No. 19 Dam	Green Mountain Power Corporation	Hydroelectric	Significant
Indian Brook Reservoir Dam	Town of Essex		High
Lower Pond Dam	*[Privately-owned]*	*[Not identified]*	Significant
Mill Pond Dam	*[Privately-owned]*	Recreation	Significant
Peterson Dam	Green Mountain Power Corporation	Hydroelectric	High
Village at Dorset Park Pond #3 Dam	Dorset Park Community Association	Flood Risk Reduction	Significant

[43] 2017 Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan, March 6, 2017; p. 65.
[44] National Inventory of Dams, https://nid.sec.usace.army.mil
[45] Ibid.

Although the Essex No. 19 Dam is located within Chittenden County on the Winooski River, another dam location outside the county's boundaries has the potential to impact the planning area. The Waterbury Reservoir dam, which is owned by the Vermont ANR, is located on Little River above its confluence with the Winooski River upriver from the Town of Bolton and is further discussed in the Bolton Jurisdictional Annex. The Waterbury Reservoir dam is classified as a High Hazard dam and has an Emergency Action Plan in place.

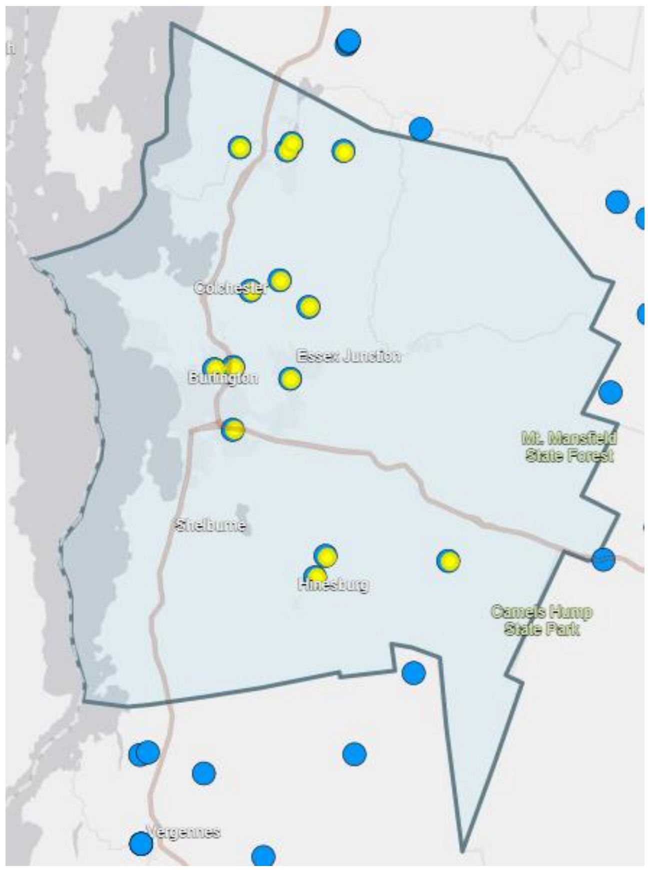


Figure 4.1.1: National Inventory of Dams Locations in Chittenden County (indicated in yellow)[46]

[46] U.S. Army Corps of Engineers, National Inventory of Dams, 2021; Interactive Maps. Retrieved at: https://nid.sec.usace.army.mil/#/

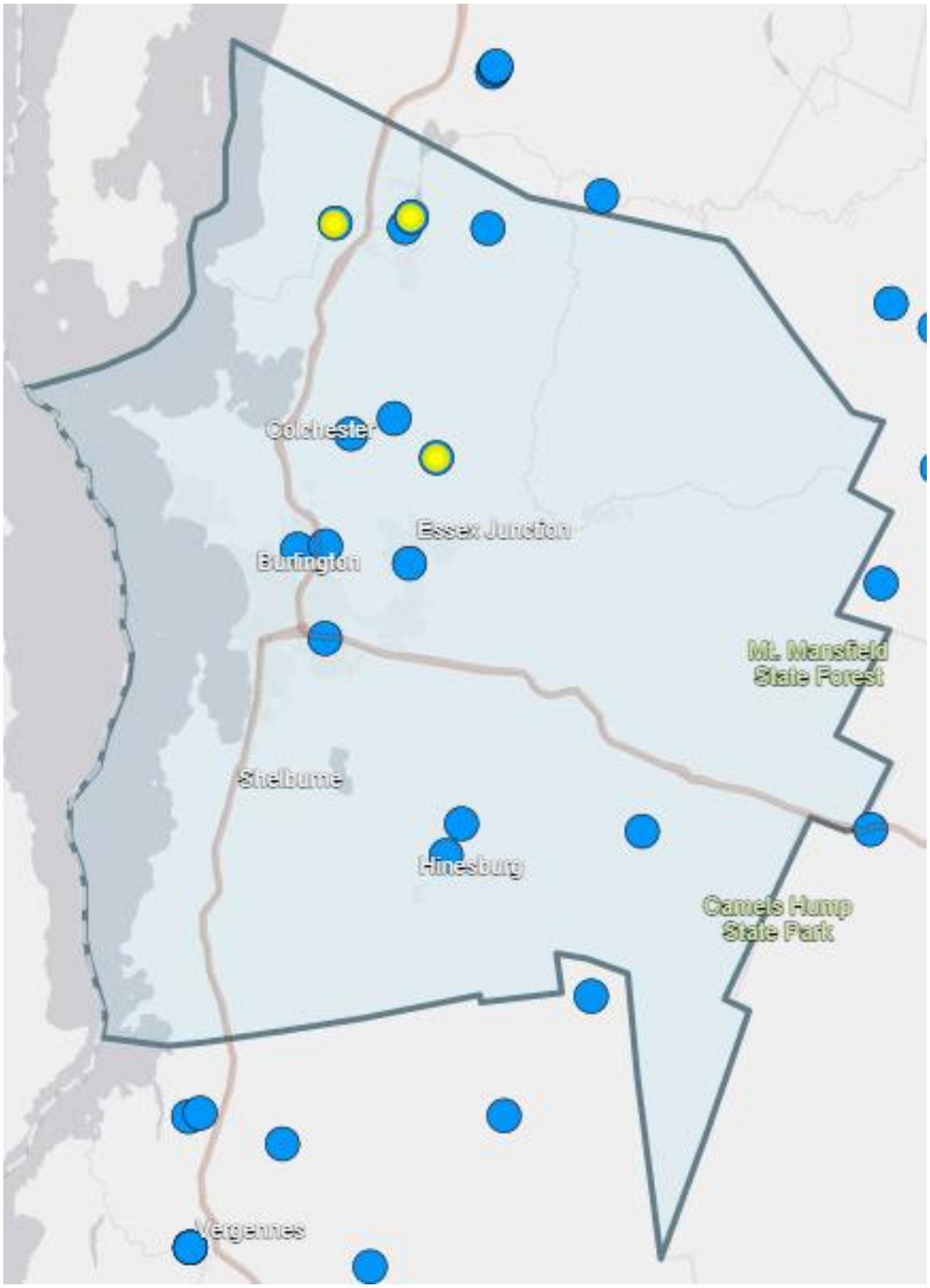


Figure 4.1.2: National Inventory of Dams High Hazard Dam Locations in Chittenden County (indicated in yellow)[47]

[47] Ibid.

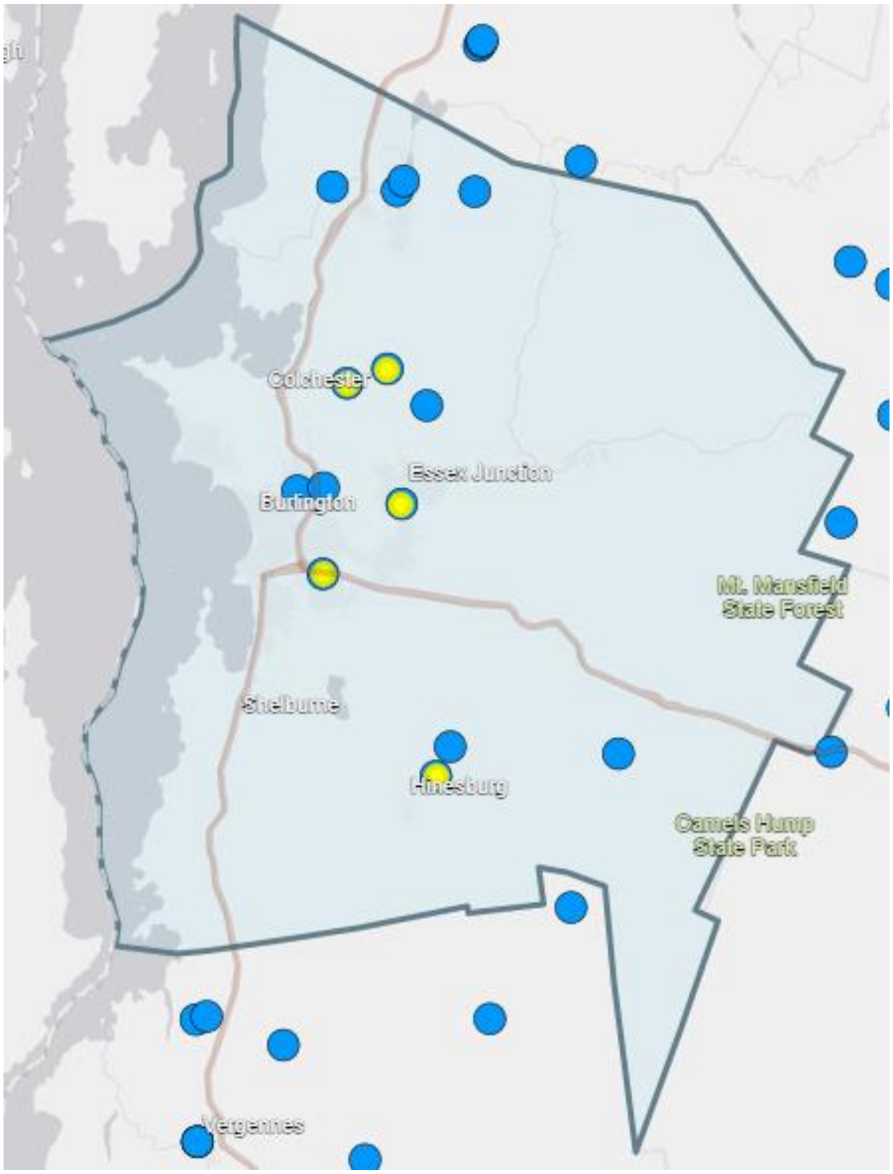


Figure 4.1.3: National Inventory of Dams Significant Hazard Dam Locations in Chittenden County[48]

The 2018 SHMP identifies two high-risk dam inundation areas within Chittenden County for which there is full or partial inundation mapping available:

- Clarks Falls Dam, Lamoille River
- Peterson Dam, Lamoille River

Extent

Both the NID and the state agencies that regulate dams use the same classification terminology to categorize the hazard potential of dams – high, significant, or low. The classification of each

[48] Ibid.

dam may change over time, as it is tied to how the failure of the dam may lead to loss of life and property downstream in the event of failure. Hazard classifications are not related to the physical condition or structural integrity of the dam (nor the probability of its failure), but strictly to the potential for adverse downstream effects from failure or mis-operation of the dam or facilities.

Previous Occurrences

Although dam failures are somewhat common occurrences in Vermont, there have been no significant occurrences within Chittenden County since the 2017 plan.

The *2018 SHMP* provides a brief profile of dam failure within the Inundation Flooding and Fluvial Erosion section but does not separate dam failure events from previous incidents of flooding and fluvial erosion.

In a report of the Vermont ANR of April 2008, updated in April 2014, 66 dam failures between 1852 and 2014 that resulted in a substantial draining of the impoundment behind the dam are described. The list is based on information from Vermont DEC and identifies the dam's name, town, date and time of failure, age of the dam, cause of failure, dam height, pond size, loss of life and additional remarks about the incident. Two significant events, neither occurring within Chittenden County, demonstrate the potential impacts from a dam failure"

- In **August 2011**, the remnants of Tropical Storm Irene caused multiple dam failures in numerous locations, primarily due to embankment failure of earthen dams, overtopping, and piping. The combination of impacts from the storm resulted in a Federal Disaster Declaration (DR-4022-VT, declared on September 1, 2011).
- The only confirmed loss of life related to dam failure was in an incident on **February 11, 1852**, when a dam embankment carrying the new Bennington and Rutland Railroad failed along Paran Creek. According to the report, "all dams, bridges, structures" were reported destroyed downstream[49]. The four- to five-hour warning time was credited with preventing further loss of life.

Probability of Future Occurrences

Between the first documented dam failure in 1848 and 2017, dam failures have occurred within the United States on an average of nearly 10 failures a year, mostly linked to small dams that result in limited flooding and downstream impact[50]. Since 1980 when dam safety became a national priority, the annual average of dam failures has increased to 24; however, in 96 percent of dam failure events the resulting flooding does not result in deaths or significant property

[49] Vermont Agency of Natural Resources, "Dam Failures in Vermont: A Partial Listing". Dated April 2008, updated April 2014: Retrieved at: https://legislature.vermont.gov/Documents/2016/WorkGroups/House%20Fish%20and%20Wildlife/Bills/H.37/Witness%20Testimony/H.37~Rep.%20David%20Deen~Dam%20Failures%20in%20Vermont%20-%20A%20Partial%20Listing%20-ANR~4-21-2015.pdf

[50] National Performance of Dams Program, Dept. of Civil & Environmental Engineering (NPDP-01 V1), Stanford University. September 2018; http://npdp.stanford.edu/sites/default/files/reports/npdp_dam_failure_summary_compilation_v1_2018.pdf

damage[51].

Within the state of Vermont, the ANR listing of incidents since 1852 documents 19 occurrences statewide since 2000, which would indicate a statewide return period of .90 percent, or slightly less than one incident per year. Because there is no data related to previous occurrences in Chittenden County, a return interval specific to the planning area cannot be calculated.

Predicting the probability of dam failure within Chittenden County requires a more detailed, site-specific engineering analysis for each dam in question since failure may result from hydrologic and hydraulic design limitations, or from geotechnical or operational factors. The *2018 SHMP* noted that the DEC, Dam Safety Program was in the process of developing new dam breach analyses, flood mapping, and Emergency Action Plans for the three Winooski River Flood Control Dams (Waterbury, Wrightsville, and East Barre), which are large, high hazard dams owned by the State[52]. None of these dams are located within the geographic boundary of Chittenden County.

In summary, dam failure is considered a **low probability** in Chittenden County given the number of existing safety measures and rigorous inspection reporting programs in place for dam oversight. The DEC and ANR require specific operation and maintenance procedures, as well as routine inspections and regularly updated emergency action plans for each of the major and state-regulated dams in the county. As such, future damage caused by dam failure and associated dollar losses are expected to be negligible – though the danger remains real and will continue to receive critical attention through the agencies' dam safety programs.

4.1.2 RISK ASSESSMENT

While dams offer many benefits, they also can pose a risk to communities if not designed, operated, and maintained properly. In the event of a dam failure, the energy of the water stored behind even a small dam can cause loss of life and significant property damage if development exists downstream of the dam. Downstream properties may be quickly submerged in floodwaters and residents may become trapped by this rapidly rising water. The failure of dams has the potential to place large numbers of people and significant amounts of property in harm's way.

Dams are inspected by the dam owners and operators on a varied basis and a hazard classification is assigned. Dams owned by Green Mountain Power are required by their permit from the Federal Energy Regulatory Commission to be inspected and maintained annually, and to update emergency action plans, communicate with emergency response organizations of municipalities located downstream of each dam, and maintain and periodically update inundation maps.

[51] Ibid.
[52] 2018 Vermont State Hazard Mitigation Plan, p. 60.

Due to the lack of specific data on dam failure probability or inundation zones available at the time of this update, the potential risk to critical facilities and existing buildings and infrastructure was not estimated for this update of the Plan.

People

Within at least the past 90 years, there has been no record of loss of life related to one of these events. Nevertheless, dam failures within Chittenden County or outside the county could impact county municipalities and threaten loss of life.

Persons living within the dam inundation areas may be affected by dam failure if there is little to no advance warning that would allow them to evacuate in a timely fashion. Because many dams are used for recreational purposes and are located adjacent to parks and other open spaces where visitors may gather, dam failure may affect those who do not live nearby but who enjoy visiting the recreational amenities.

Built Environment, Community Lifelines and Assets

Dams of any age can fail; however, many dam structures, constructed of earth, timber, stone, concrete, or combinations thereof, are over 50 years old and have not been consistently maintained during their useful life. Frequently the dams serve a function of holding back water that could damage or destroy critical infrastructure such as roads, bridges, and culverts, but also have the potential to impact homes, businesses, farms, parks, cultural and historical assets, and greenspace. Any or all of these may be damaged during a dam failure.

Hydroelectric facilities, water supply sources, water distribution systems, and wastewater treatment systems are also at risk for flood damage resulting from dam failure. These critical facilities are often located in floodplains. The Source Protection Plans (SPP) required by public water systems should address risks, provide mitigation strategies, and contain contingency plans for water source problems, including floods.

Green Mountain Power, which owns several of the dams on the Winooski River, maintains maps of areas that would be inundated in a dam failure, and the state has similar maps for state-owned dams, both in Chittenden County and upstream on the Winooski River.

Natural Environment

The natural environment comprises open spaces and other resources that may also include the built environment, such as parks that encompass trees or waterways. The natural environment would be affected by dam failure if trees are damaged or there is soil erosion as a result of heavy water overflow. Agricultural lands, while developed, may include shrubbery, water sources, crops, or livestock.

Economy

Failure of dams may result in catastrophic localized damage to homes, businesses, and other properties. Vulnerability to dam failure is contingent on dam operations planning and the nature of downstream development. Depending on the elevation and storage volume of the impoundment, the amount of water released could impact businesses located within the inundation area. Nearby commercial establishments, including those of persons who manage a home-based business, may be affected.

Hazard Risk Summary

Dam failure hazard risk was not rank by participating municipalities as part of the 2022 plan update process. [53]

4.1.3 VULNERABILITY ANALYSIS

Historical

Due to the lack of specific data related to previous dam failure events in the planning area, it is difficult to identify the exact exposure of the population, property, economy, or environment related to this hazard. Enhanced coordination in the future between emergency managers and dam owners and operators, the United States Army Corps of Engineers (USACE), and Vermont DEC and ANR, will improve the availability of critical data and information, including inundation mapping, necessary to quantify potential vulnerability and identify appropriate mitigation actions.

Scenario

Due to the lack of availability of specific data on dam failure probability or inundation zones, the potential vulnerability to critical facilities and existing buildings and infrastructure was not estimated for this revision of the Plan. Site-specific dam emergency action plans and inundation mapping that could be available in the next planning cycle should be reviewed to identify potential exposure of population and property. Future hazard exercises could be developed to aid in quantifying vulnerability specific to individual dams.

Future Population and Development Trends

A comprehensive discussion of potential impacts of future population growth and development to all hazards is presented in **Section 4, Base Plan**. Planned development that occurs within dam inundation zones should be monitored during the next planning cycle to identify potential impacts related to dam failure.

Public Input

[53] Due to minimal data and information related to previous occurrences and extent, Dam Failure was not ranked by the jurisdictions for hazard risk for this Plan update but will be included in the all-hazards ranking in the next update.

A Public Hazard Survey made available to the public during the planning process indicated that approximately 1.27 percent of the more than 200 survey respondent households had directly experienced dam failure within the previous five years, but 71.5 percent were not concerned about future dam failure. On a ranking of the most important community assets, survey responders were most concerned about local government facilities.

Opportunities for Mitigation

In recent years, FEMA has recognized the need to address the high level of vulnerability of dams in recognition of the nation's overall infrastructure deterioration. Concern about the safety of dams and potentially affected communities led to the development of the **National Dam Safety Program/High Hazard Potential Dam Grant Program**, that may be utilized for eligible mitigation projects. Individual municipalities may wish to consider this potential funding source for improving the security of dams deemed to be at high or significant risk.

Table 4.1.4: National Dam Safety Program/High Hazard Potential Dam Grant Program

The Vermont Department of Environmental Conservation (DEC) serves as the state's Dam Safety Agency, working in partnership with federal agencies and other stakeholders under the National Dam Safety Program to encourage and promote the establishment and maintenance of effective federal and state dam safety programs to reduce the risk to human life, property, and the environment.

For the purposes of the HHPD program, all dam risk includes the incremental risk, non-breach risk, and residual risk associated with each eligible high hazard potential dam, as well as the reason(s) the state has determined the dam is an eligible high hazard potential dam.

The High Hazard Potential is a classification standard for any dam whose failure or mis-operation will cause loss of human life and significant property destruction. There are 11 dams ranked as Significant hazard, and three ranked as High hazard in the Chittenden County planning area.

For the purpose of the HHPD program, all dam risk includes the incremental risk, non-breach risk, and residual risk associated with each eligible high hazard potential dam, as well as the reason(s) the state has determined the dam is an eligible high hazard potential dam. To be eligible for the HHPD grant, the high hazard dam must have an emergency action plan approved by the oversight agency, and the dam must fail to meet minimum dam safety standards of the state and pose an unacceptable risk to the public.

***Funding** from the HHPD program provides technical, planning, design and construction assistance for eligible rehabilitation activities that reduce dam risk and increase community preparedness.*

***Objectives** of the program include:*

1. Provide financial assistance for repair, removal, or rehabilitation of eligible high hazard potential dams.
2. Protect the federal investment by requiring operation and maintenance of the project for the 50-year period following completion of rehabilitation.
3. Encourage state, local, and territorial governments to consider all dam risk in state and local mitigation planning.

4. Promote community preparedness by requiring recipients to develop and implement floodplain management plans that address potential measures, practices, and policies to reduce loss of life, injuries, damage to property and facilities, public expenditures, and other adverse effects of flooding in the area impacted by the project; plans for flood fighting and evacuation; and public education and awareness of flood risks.
5. Reduce the potential consequences to life and property of high hazard potential dam incidents.
6. Incentivize states to incorporate risk-informed analysis and decision making into their dam safety practice.
7. Reduce the overall number of high hazard potential dams that pose an unacceptable risk to the public.
8. Promote a program of Emergency Action Plan (EAP) implementation, compliance, and exercise for high hazard potential dams.
9. Reduce costs associated with dam rehabilitation through the deployment of innovative solutions and technologies.

***Eligible activities** include the repair, removal, or rehabilitation of eligible high hazard potential dams. For the purposes of the HHPD Grant Program, rehabilitation means the repair, replacement, reconstruction, or removal of a dam that is carried out to meet applicable state dam safety and security standards.*

*The HHPD grant **period of performance** is 36 months from the date of the award.*

Specific Criteria for the HHPD grant program are provided in the publication FEMA Policy 104-008-7

Factors for Consideration in the Next Planning Cycle

Future monitoring, evaluating, and updating of this plan should consider the following factors related to dam failure, as well as other information from the Vermont SHMP updates:

- Have dam failure events occurred within the planning area since adoption of the 2022 *MJAHMP*?
- Did dam failure events take place in areas outside of the planning area that impacted the planning area by virtue of their being located upstream of the planning area?
- Has any new scientific research or methodology changed the ability to predict dam failure events or assess risk and vulnerability?
- Has there been significant change in the population, built environment, natural environment, or economy that could affect the risk or vulnerability to dam failure?
- Is there new evidence related to the impacts of climate change that could affect the level of risk or vulnerability in relation to dam failure?

SECTION 4.2 Extreme Temperatures (Extreme Cold and Extreme Heat)

2022 HMP Update
The 2022 plan update continued to incorporate formatting changes and analyses implemented in the 2017 plan. These changes include, but are not limited to: • The Extreme Temperatures hazard was reexamined, and a new analysis performed. • Refreshing the hazard profiles for Extreme Cold and Extreme Heat. • Determining the number of hazard events and losses by jurisdiction using National Centers for Environmental Information (NCEI) and other data sources where available. • Updating the previous occurrences. • Updating the assessment of risk by jurisdiction based on new data. • Ranking the hazard by jurisdiction using the methodology described in Section 4, Base Plan. • Reformatting sections to improve clarity and, as available and appropriate, incorporate new maps and imagery.

<table>
<tr><th colspan="5">Extreme Temperatures</th><th>Overall Vulnerability</th></tr>
<tr><th colspan="5">Definition, Key Terms, and Overview</th><td rowspan="5">Low</td></tr>
<tr><td colspan="5">Extreme Cold-Although no specific definition exists for Extreme Cold, the following are characteristics of an Extreme Cold event in Vermont:
• Temperatures at or below zero degrees for an extended period. Note that Extreme Cold events are usually part of winter storms but can occur during anytime of the year and have devastating effect on the state’s agricultural production.
• National Weather Service (NWS) Extreme Cold Warnings are issued when apparent temperatures (wind chill or ambient temperatures) reach -30 degrees Fahrenheit or colder. NWS Cold Advisories are issued when apparent temperatures reach between -20 and -29 degrees Fahrenheit.
Extreme Heat-Temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks are defined as extreme heat.
• Local Officials need to look at extended duration events and impacts on their community for their own decision-making criteria. NWS Extreme Heat Warnings are issued when apparent temperatures (Heat Index) reach 105 degrees.</td></tr>
<tr><th rowspan="2">Frequency</th><th rowspan="2">Probability</th><th colspan="3">Potential Magnitude</th></tr>
<tr><th>Injuries/Deaths</th><th>Infrastructure</th><th>Environment</th></tr>
<tr><td>Low</td><td>Low</td><td>Moderate</td><td>Moderate</td><td>Moderate</td></tr>
</table>

4.2.1 HAZARD PROFILE

Heat is one of the leading weather-related killers in the United States, despite the ability to prevent or reduce the risk of heat exhaustion and heat stroke through outreach and intervention[54]. Similarly, extremely cold temperatures have resulted in lives lost and damage to infrastructure.

Other natural hazards such as floods and severe winter weather occur more frequently in Chittenden County and serve to overshadow extreme temperature in consideration for hazard mitigation planning; however, its effects can have devastating consequences, especially to people. Based on previous occurrences and the threat to the population, this section profiles the hazard and provides justification for a **minimal vulnerability assessment**. This section also emphasizes the role of preparedness education and early warning in reducing the threat to humans from extreme temperatures.

Extreme Cold

Every winter, extremely cold air affects multiple parts of the country and impacts millions of people. Cold arctic air joining together with brisk winds leads to dangerously cold wind chill values. People exposed to extreme cold are susceptible to frostbite in a matter of minutes. Areas of the body most prone to frostbite are uncovered skin and extremities, such as hands and feet. Hypothermia is another threat during extreme cold, occurring when the body loses heat faster than it can be produced.

Cold weather can also affect crops, especially in late spring or early fall, when cold air outbreaks can damage or kill produce for farmers, as well as residential plants and flowers. A freeze occurs when the temperature drops below 32 degrees Fahrenheit (F). Freezes and their effects are significant during the growing season. Plant species have different tolerances to cold temperatures.

Extreme Heat

Atmospheric variables can affect the impacts of extreme heat. Humid conditions add to human discomfort with high temperatures and can increase the adverse effects of prolonged exposure to high temperatures. Additionally, extended periods of hot weather in combination with a lack of rainfall and dry conditions can lead to drought or wildfires and resulting impacts to crops and livestock, and indirectly, the economy.

The relationship between heat and humidity is best explained through the Heat Index Chart, developed by the National Weather Service (NWS) as a means of portraying how the combined threat of heat and humidity impact people.

Table 4.2.1: Hazard Profile Summary for Extreme Temperatures

[54] EPA's *Excessive Heat Events Guidebook* at: www.epa.gov/heatisland/about/pdf/EHEguide_final.pdf).

Extreme Temperatures (Including Extreme Cold and Extreme Heat) – LOW RISK			***Potential Cascading Effects***
	Location	Jurisdiction-wide	• Power/utility outages (No heat) • Traffic/roadway damage or closures • High demand on healthcare system • Responder health • Delay in delivery of services • Redirect industry/government assets (people/equipment) • Loss of Revenue
	Extent	Mild to severe Damage to property, turf, wildlife, urban forest	
	Duration	Several hours to days	
	Probability	High	
	Seasonal Pattern	Seasonal temperature peaks	
	Speed of Onset	Slow to Rapid	
	Warning Time	Hours to days	
	Repetitive Loss	N/A	

Location

Extreme temperatures (heat and cold) are not a hazard with a defined geographic boundary. All areas of Chittenden County are subject to extreme temperature hazards, although areas at higher elevations may experience temperatures a few degrees colder, on average, than the lower elevations. Extreme Cold can occur as a singularly cold day or as an extended period.

Extent

Extreme Cold

The National Weather Service office at Burlington International Airport tracks extreme cold events.

Table 4.2.2. Lowest Recorded Temperatures at Burlington International Airport, South Burlington (1884-2021)[55]

Date(s)	Temperature
Feb. 12th, 1979	-30 degrees
Jan. 15th, 1957	
Jan. 27th, 1994	-29 degrees
Dec. 29th & 30th, 1933	
Feb. 9th, 1934	-28 degrees
Feb. 1st, 1920	
Feb. 7th, 1993	-27 degrees
Jan. 4th, 1981	
Feb. 11th, 1979	
Jan. 11th, 1968	
Jan. 31st, 2020	
Feb. 5th, 2008	

[55] National Weather Service, Burlington International Airport, South Burlington. Retrieved at: https://www.weather.gov/btv/climate

Table 4.2.3. Number of Consecutive Days Minimum Temperatures Below or Equal to Zero at Burlington International Airport, South Burlington (1884-2021)[56]

Rank	Run Length (days)	Ending Date
1	12	2/20/1979
2	11	1/18/1981
3	11	1/22/1920
4	10	12/30/1989
5	10	2/21/1967
6	10	1/9/1970
7	10	1/14/1968
8	9	1/23/1994
9	9	2/10/1974
10	9	2/18/1968
11	9	2/18/1956
12	9	2/11/1948
13	9	2/1/1935
14	9	2/10/1934
15	8	1/9/1996
16	8	1/6/1981
17	8	2/26/1959
18	8	3/1/1907
19	8	1/14/1884
20*	7	1/31/2007
***Value also occurred in one or more previous years.**		
****Period of record 1/1/1884 to 2/11/20**		

The information that can be extrapolated from available data shows that in areas normally cooler than the rest of the United States during the hot summer month of August, the climate has changed so that now those Northern areas are becoming hotter. This, in turn, affects people living there by causing cooling issues in homes that were not built with central or window air conditioners. This increase in heat can also affect crops or livestock in the region by evaporating the water source used to hydrate them and causing body temperatures in livestock to rise higher than safe levels. This also affects the water supply for the crops by removing the moisture from the soil and causing drought or drought-like conditions that if prolonged can cause long term damage to the economy.

[56] National Weather Service, Burlington International Airport, South Burlington. Retrieved at: https://www.weather.gov/btv/climate

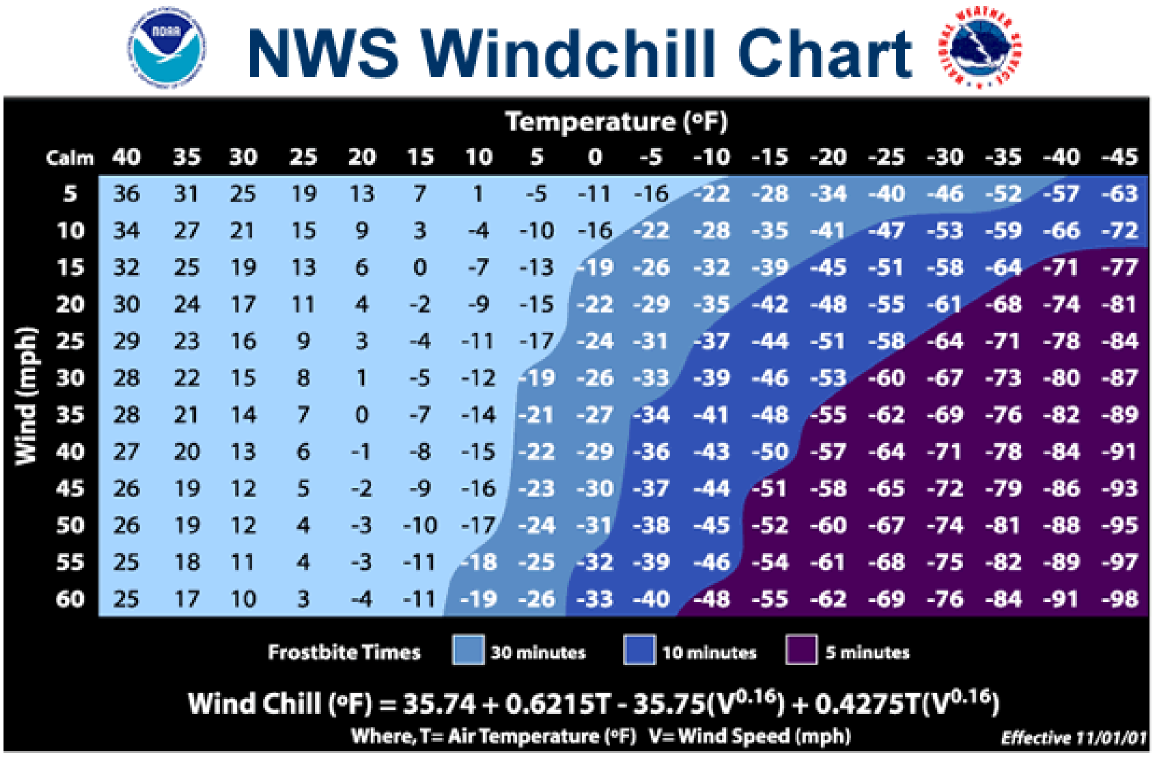
Table 4.2.4. Average monthly temperatures, Burlington Int'l Airport at South Burlington[57]

Average monthly temperatures, Burlington Int'l Airport @ South Burlington						
	January	February	March	April	May	June
Average high in °F	27	21	40	55	67	76
Average low in °F	10	13	22	35	45	55
	July	August	September	October	November	December
Average high in °F	81	79	70	57	46	33
Average low in °F	60	58	51	39	31	19

Extreme cold has a wide range of extent and severity markers and characteristics. The National Weather Service Issues Extreme Cold Warnings when the temperature feels like it is -30 degrees Fahrenheit or colder across a wide area for a period of at least several hours. When possible, these advisories are issued a day or two in advance of the onset of the conditions.

Perhaps the most common extent/severity marker for extreme cold is the Wind Chill scale. The National Weather Service's methodology for determining wind chill uses wind speed and actual temperature. While wind chill is not necessarily related to extreme cold as a single cause, the advisory system that the NWS currently uses relies on wind chill to relay warning and advisory information to the public. Extreme cold severity is a function of wind chill and other factors, such as precipitation amount (rain, sleet, ice, and/or snow).

[57] National Weather Service, Burlington International Airport, South Burlington. Retrieved at: https://www.weather.gov/btv/climate



NWS Windchill Chart

Temperature (°F)

Wind (mph) \ Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

Figure 4.2.1: NWS Windchill Chart[58]

Extreme Heat

Extreme heat episodes do occur in Chittenden County, but rarely exceed a high of 100 degrees.

Table 4.2.5. Highest recorded temperatures at Burlington Int'l Airport at So. Burlington (1884-2021)[59]

Highest recorded temperatures at Burlington Int'l Airport at So. Burlington 1884-2021	
Highest	
101 Degrees	Aug. 11th, 1944
100 Degrees	Jul. 14th, 1995
	Jun. 19th, 1995
	Jul. 3rd, 1911
99 Degrees	Aug. 9th, 2001
	Jul. 20th, 1977
	Aug. 2nd, 1975
	Jul. 18th, 1953

58 National Weather Service, Burlington International Airport, South Burlington. Retrieved at: https://www.weather.gov/btv/climate

59 National Weather Service, Burlington International Airport, South Burlington. Retrieved at: https://www.weather.gov/btv/climate

Highest recorded temperatures at Burlington Int'l Airport at So. Burlington 1884-2021	
98 Degrees	Jul. 19th, 2013
	Sept. 9th, 2002
	Aug. 1st, 1975
	Jul. 29th, 1949
	Jul. 3rd, 1966
	Jul. 27th, 1949
	Jul. 8th, 1921
	Aug. 1st, 1917
	Jul. 4th & 5th, 1911

Table 4.2.6. Maximum Five-Day Mean Maximum Temperatures Recorded at Burlington International Airport at South Burlington (1884-2021)[60]

Rank	Value	Ending Date	Missing Days
1	96.2	7/6/1911	0
2	96.0	8/15/1944	0
3	95.6	7/30/1949	0
-	95.6	8/14/1944	0
5	95.4	8/17/1944	0
6	95.2	7/29/1963	0
-	95.2	7/5/1911	0
8	95.0	8/16/1944	0
9	94.4	7/28/1963	0
10	94.2	8/10/2001	0
Last value also occurred in one or more previous years			
Period of record 12/01/1883 to 02/11/2016			

Despite the lack of data outside of that collected at the National Weather Service station, the Chittenden County Regional Planning Commission (CCRPC) and its member municipalities recognize the damage that has been and could be caused by this hazard and therefore have included it in this *MJAHMP*.

Health planners have begun to look at the relative vulnerability of a municipality's residents to heat-related illnesses. In May 2016 the Vermont Department of Health (VDH), Vermont Climate & Health Program, issued a report entitled: *Heat Vulnerability in Vermont: Local Indicators of Heat Illness Risk*. The report's introduction notes as follows:

60 National Weather Service, Burlington International Airport, South Burlington. Retrieved at: https://www.weather.gov/btv/climate

> *"Vermonters are at greater risk for serious heat-related illnesses, and even death, when the statewide average temperature reaches 87°F or hotter."*

To better understand the geographic variability of heat illness risk within Vermont, the Health Department has developed a heat vulnerability index. The heat vulnerability index uses state and federal data sources to quantify the risk for heat-related illness at the town/city level in Vermont. Indicators are mapped individually, combined into index indicators for six different categories of risk, and further combined to provide a composite heat vulnerability index. Six types of risk indicators were used - population, socioeconomic, health, environmental, acclimation, and historic heat emergencies.

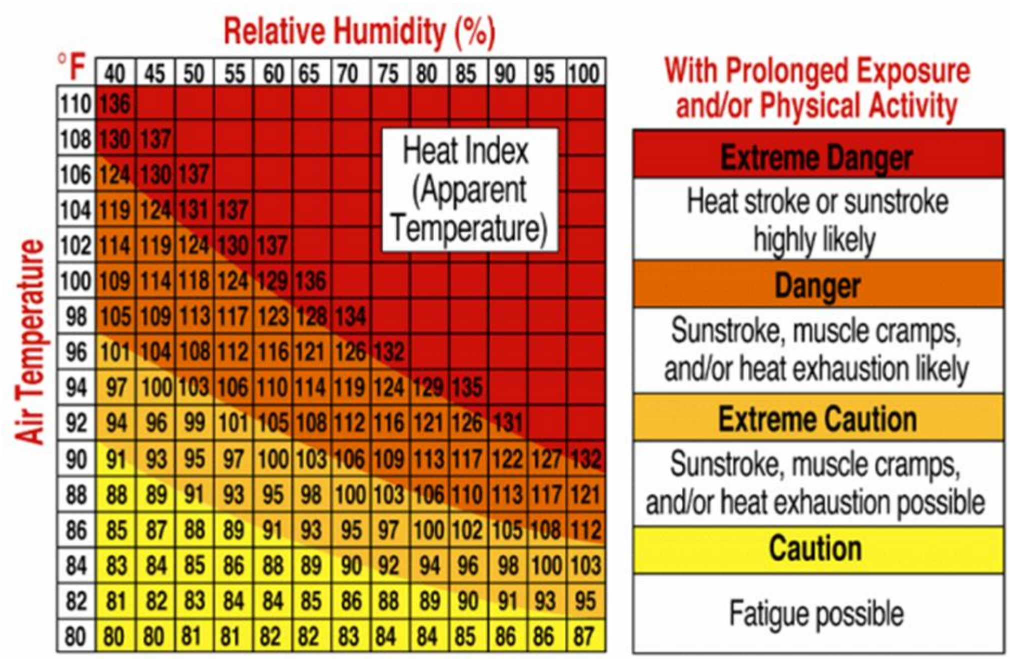
Overall, the county, as a whole, was less vulnerable compared to the statewide average with thirteen of the county's municipalities having an index greater than 1.5 standard deviations lower; four communities having an index greater than 0.5 to 1.5 standard deviations lower; and only the urban communities of Burlington and Winooski having an average vulnerability of +0.5 to -0.5 standard deviations. These two communities score relatively poorly on the Socioeconomic Vulnerability as, according to VDH, for example, "older adults living alone, those with less education, and those with fewer economic resources are often less able to find relief during summer heat events. "

The National Weather Service (NWS) issues a range of watches and warnings associated with extreme heat:

- **Excessive Heat Outlook**: when the potential exists for an excessive heat event in the next three to seven days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.
- **Excessive Heat Watch**: when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set plans in motion can do so, such as establish individual community excessive heat mitigation plans.
- **Excessive Heat Warning/Advisory**: when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

The NWS also developed the Heat Index (HI), sometimes referred to as the "apparent temperature". The HI, given in degrees Fahrenheit (F), is a measure of how hot it really feels when relative humidity (RH) is added to the actual air temperature. To find the HI, NWS uses the Heat Index Chart. As an example, if the air temperature is 96 degrees F and the RH is 65 percent , the HI - or how hot it really feels - is 121 degrees F..

Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15 degrees F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous. The exposure categories associated with the Heat Index identify specific health and medical issues associated with the apparent temperatures.



Relative Humidity (%)

Air Temperature °F	40	45	50	55	60	65	70	75	80	85	90	95	100
110	136												
108	130	137											
106	124	130	137										
104	119	124	131	137									
102	114	119	124	130	137								
100	109	114	118	124	129	136							
98	105	109	113	117	123	128	134						
96	101	104	108	112	116	121	126	132					
94	97	100	103	106	110	114	119	124	129	135			
92	94	96	99	101	105	108	112	116	121	126	131		
90	91	93	95	97	100	103	106	109	113	117	122	127	132
88	88	89	91	93	95	98	100	103	106	110	113	117	121
86	85	87	88	89	91	93	95	97	100	102	105	108	112
84	83	84	85	86	88	89	90	92	94	96	98	100	103
82	81	82	83	84	84	85	86	88	89	90	91	93	95
80	80	80	81	81	82	82	83	84	84	85	86	86	87

Heat Index (Apparent Temperature)

With Prolonged Exposure and/or Physical Activity

Extreme Danger	Heat stroke or sunstroke highly likely
Danger	Sunstroke, muscle cramps, and/or heat exhaustion likely
Extreme Caution	Sunstroke, muscle cramps, and/or heat exhaustion possible
Caution	Fatigue possible

Figure 4.2.2: NOAA's National Weather Service Heat Index.[61]

When extreme heat occurs or is forecast to occur, the NWS issues heat advisories based on heat indices; these advisories are issued through the media and the Emergency Alert System. The NWS provides assistance to state and local health officials in preparing civil emergency messages for severe heat waves, in addition to preparing special weather statements that define who is most at risk, safety rules, and the expected severity of the situation. The NWS also aids state and local authorities with issuing warnings and survival tips.

Previous Occurrences

The National Oceanic and Atmospheric Administration's (NOAA), National Centers for Environmental Information (NCEI) documents extreme temperatures events for Chittenden County in its Storm Events Database. They occurred throughout the planning region but vary widely in terms of location, magnitude, and impact. Where possible, NCEI tracks reports separately by impacted jurisdiction, although it is not always possible to track damage below a county or city level. From 1950 to 2021, there have been at least 57 extreme temperature event reports recorded by the NCEI for Chittenden County. Approximately $850,000 in crop damage and no property damage was recorded for these events, though other damages have

[61] National Weather Service, Burlington International Airport, South Burlington. Retrieved at: https://www.weather.gov/btv/climate

undoubtedly occurred as an indirect result of the hazard. In addition, there were thirteen fatalities recorded. Additionally, there have been 3 heat deaths on 7/1/2018.

- **July 1, 2018:** A dangerous heat wave, one of which that likely hasn't impacted the North Country in decades occurred between June 30th and July 5th. High temperatures exceeded 90 degrees for at least 5 of the six days in many locations were above 85 degrees for 7 days. Heat indices, the combination of temperature and humidity, were recorded in the 100 to 110 range considered excessive and very dangerous. A substantial increase in hospitalizations occurred due to the excessive heat and duration and at least 4 deaths were attributed to the heat. Burlington VT witnessed the warmest 5 and 6 Day Consecutive stretch since records have been kept in 1892. Also, the ALL-TIME warmest minimum temperature was recorded on July 2nd of 80 degrees, breaking the old record of 78 degrees. High temperatures in the upper 80s to upper 90s with dewpoints in the 60s and 70s created dangerous heat indices in the 95 to 110 degree range between June 30th and July 5th. Three fatalities were reported in official state health department records. A 79-year-old female in Essex Junction, 57-year-old female in Milton, and 71-year-old male all died in their places of residence from Hyperthermia. Increased hospitalization visits also occurred due to the dangerous heat.

Table 4.2.7a. NCEI Extreme Cold/Wind Chill Events in Chittenden County 1950-2021[62]

Location	Date	Type	Inj	Dth	PrD	CD
EASTERN CHITTENDEN (ZONE)	01/25/2007	Extreme Cold/wind Chill	0	0	0	0
WESTERN CHITTENDEN (ZONE)	01/25/2007	Extreme Cold/wind Chill	0	0	0	0
EASTERN CHITTENDEN (ZONE)	03/06/2007	Extreme Cold/wind Chill	0	0	0	0
WESTERN CHITTENDEN (ZONE)	03/06/2007	Extreme Cold/wind Chill	0	0	0	0
WESTERN CHITTENDEN (ZONE)	03/09/2007	Extreme Cold/wind Chill	0	0	0	0
EASTERN CHITTENDEN (ZONE)	03/09/2007	Extreme Cold/wind Chill	0	0	0	0
EASTERN CHITTENDEN (ZONE)	01/14/2009	Extreme Cold/wind Chill	0	0	0	0

[62] National Oceanic and Atmospheric Administration (NOAA), National Center for Environmental Information (NCEI), Storm Database for January 1, 1950 to May 31, 2021.

WESTERN CHITTENDEN (ZONE)	01/14/2009	Extreme Cold/wind Chill	0	0	0	0
EASTERN CHITTENDEN (ZONE)	01/07/2015	Extreme Cold/wind Chill	0	0	0	0
WESTERN CHITTENDEN (ZONE)	01/07/2015	Extreme Cold/wind Chill	0	0	0	0
EASTERN CHITTENDEN (ZONE)	01/11/2022	Extreme Cold/wind Chill	0	0	0	0
EASTERN CHITTENDEN (ZONE)	01/14/2022	Extreme Cold/wind Chill	0	0	0	0
WESTERN CHITTENDEN (ZONE)	01/14/2022	Extreme Cold/wind Chill	0	0	0	0
WESTERN CHITTENDEN (ZONE)	01/14/2022	Extreme Cold/wind Chill	0	0	0	0
Total			0	0	0	0

Table 4.2.7b. NCEI Cold/Wind Chill Events in Chittenden County 1950-2021[63]

Location	Date	Type	Inj	Dth	PrD	CD
WESTERN CHITTENDEN (ZONE)	01/06/1996	Cold/wind Chill	00:00	0	0	0
WESTERN CHITTENDEN (ZONE)	01/17/1997	Cold/wind Chill	00:00	0	0	0
WESTERN CHITTENDEN (ZONE)	01/19/1997	Cold/wind Chill	00:00	0	0	0
CHITTENDEN (ZONE)	12/30/1998	Cold/wind Chill	00:00	0	0	0
WESTERN CHITTENDEN (ZONE)	01/13/2004	Cold/wind Chill	18:00	0	0	0
WESTERN CHITTENDEN (ZONE)	01/15/2004	Cold/wind Chill	12:00	0	100.000	0
EASTERN CHITTENDEN (ZONE)	01/15/2004	Cold/wind Chill	12:00	0	0	0

[63] National Oceanic and Atmospheric Administration (NOAA), National Center for Environmental Information (NCEI), Storm Database for January 1, 1950 to May 31, 2021.

WESTERN CHITTENDEN (ZONE)	01/18/2005	Cold/wind Chill	00:01	0	0	0
EASTERN CHITTENDEN (ZONE)	01/18/2005	Cold/wind Chill	00:01	0	0	0
EASTERN CHITTENDEN (ZONE)	01/20/2005	Cold/wind Chill	15:00	0	0	0
WESTERN CHITTENDEN (ZONE)	01/20/2005	Cold/wind Chill	15:00	0	0	0
WESTERN CHITTENDEN (ZONE)	01/23/2005	Cold/wind Chill	11:00	0	0	0
EASTERN CHITTENDEN (ZONE)	01/23/2005	Cold/wind Chill	11:00	0	0	0
EASTERN CHITTENDEN (ZONE)	01/15/2006	Cold/wind Chill	06:00	0	0	0
WESTERN CHITTENDEN (ZONE)	01/15/2006	Cold/wind Chill	06:00	0	0	0
WESTERN CHITTENDEN (ZONE)	02/18/2006	Cold/wind Chill	20:00	0	0	0
EASTERN CHITTENDEN (ZONE)	02/18/2006	Cold/wind Chill	20:00	0	0	0
EASTERN CHITTENDEN (ZONE)	02/27/2006	Cold/wind Chill	00:00	0	0	0
WESTERN CHITTENDEN (ZONE)	02/27/2006	Cold/wind Chill	00:00	0	0	0
WESTERN CHITTENDEN (ZONE)	12/08/2008	Cold/wind Chill	03:00	0	0	0
EASTERN CHITTENDEN (ZONE)	12/08/2008	Cold/wind Chill	03:00	0	0	0
WESTERN CHITTENDEN (ZONE)	02/01/2015	Cold/wind Chill	00:00	0	0	0
EASTERN CHITTENDEN (ZONE)	02/01/2015	Cold/wind Chill	00:00	0	0	0
Totals:				0	100,000	0

Table 4.2.7a. NCEI Extreme Heat Events in Chittenden County 1950-2021[64]

Location	Date	Type	Inj	Dth	PD	CD
WESTERN CHITTENDEN (ZONE)	01/18/1996	Heat	0	0	0	0
WESTERN CHITTENDEN (ZONE)	01/19/1996	Heat	0	0	0	0
WESTERN CHITTENDEN (ZONE)	01/27/1996	Heat	0	0	0	0
CHITTENDEN (ZONE)	12/07/1998	Heat	0	0	0	0
WESTERN CHITTENDEN (ZONE)	08/01/2006	Heat	0	0	0	0
EASTERN CHITTENDEN (ZONE)	08/01/2006	Heat	0	0	0	0
WESTERN CHITTENDEN (ZONE)	07/21/2011	Heat	0	0	0	0
EASTERN CHITTENDEN (ZONE)	03/17/2012	Heat	0	0	0	500,000
WESTERN CHITTENDEN (ZONE)	03/17/2012	Heat	0	0	0	250,000
WESTERN CHITTENDEN (ZONE)	07/01/2018	Heat	0	3	0	0
EASTERN CHITTENDEN (ZONE)	07/01/2018	Heat	0	0	0	0
WESTERN CHITTENDEN (ZONE)	05/27/2020	Heat	0	0	0	0
WESTERN CHITTENDEN (ZONE)	06/18/2020	Heat	0	0	0	0
WESTERN CHITTENDEN (ZONE)	07/07/2020	Heat	0	0	0	0
Total				3	0	750,000

[64] National Oceanic and Atmospheric Administration (NOAA), National Center for Environmental Information (NCEI), Storm Database for January 1, 1950 to May 31, 2021.

Probability of Future Occurrence

The future incidence of extreme temperatures is highly unpredictable and may be localized, which makes it difficult to assess the probability of a future occurrence. Some form of extreme temperature typically impacts the Chittenden County region annually. As a result, while the future probability of some type of extreme temperature may be estimated as High, the exact severity or manifestation of the hazard cannot be quantified at this time.

4.2.2 RISK ASSESSMENT

Community Assets at Risk

While this hazard occurs with some regularity, it is not one with a significant history of causing damage or losses to property in Chittenden County. The risk of exposure and negative health impacts to people, animals, and agriculture are the greatest risk, with the risk to the loss of utility service (particularly electrical) also a consideration. Humans and animals can be injured or die from exposure to both extreme cold and extreme heat; agriculture can be damaged or destroyed by extremes in temperature, rending crops unusable. Utility systems may fail under strains of demand, resulting in increases in exposure of humans and animals to extreme temperatures, as facilities cannot provide regulated temperatures and climate.

People

The severity of extreme temperature on a community can be magnified to the degree they affect vulnerable populations, those that may require special assistance during such events who may not be able to protect themselves prior to an event or may not understand potential risks. These can include very young and elderly populations, those without transportation resources, or those in a lower socioeconomic group. Tourists and visitors to the area also have increased risk, as they are less familiar with the geography of the area and the typical means of warning residents regarding dangerous conditions.

Health risks from extreme heat include sunburn, dehydration, heat cramps, heat exhaustion, and heat stroke. Heat disorders generally result from a reduction or collapse of the body's ability to cool itself by circulatory changes and sweating, or a chemical (salt) imbalance caused by too much sweating. When the body cannot cool itself, or when it cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise, and heat-related illness may develop. All other factors being equal, the severity of heat disorders tends to increase with age. Heat cramps in a 17-year-old may be heat exhaustion in someone who is 40, and heat stroke in a person over 60. Failure of cooling mechanisms places research, patients, and people at risk from prolonged exposure to extreme heat.

Table 4.2.8: Potential Health Hazards Associated with Heat

Category	Heat Index	Health Hazards
Extreme Danger	130 degrees Fahrenheit and Higher	Heat stroke/ sunstroke is likely with continued exposure.
Danger	105 to 129 degrees Fahrenheit	Sunstroke, muscle cramps, and/or heat exhaustion with prolonged exposure and/or physical activity.
Extreme Caution	90 to 105 degrees Fahrenheit	Sunstroke, muscle cramps, and/or heat exhaustion with prolonged exposure and/or physical activity.
Caution	80 to 90 degrees Fahrenheit	Fatigue possible with prolonged exposure and/or physical activity.

Failure of cooling mechanisms places research, patients, and people at risk from prolonged exposure to extreme heat.

Extreme cold can also have significant impacts on people. Hypothermia is most likely at very cold temperatures but can occur at higher temperatures (above 40 degrees Fahrenheit) if the person exposed is also wet from rain, sweat, or submersion. Warning signs of hypothermia include shivering, exhaustion, confusion, fumbling hands, memory loss, slurred speech, or drowsiness. In infants, symptoms include bright red and cold skin and very low energy. A person with hypothermia should receive medical attention as soon as possible, as delays in medical treatment may result in death.

Built Environment

In addition to the effects that extreme temperatures can have on people, there are also potential effects to assets. Increases in the exterior temperature means that the utilities and processes by which interior spaces are controlled and conditioned must work harder to regulate those interior temperatures. This places an additional strain on existing utility systems, which can fail under the increased workload.

Community Lifelines

Quantitative assessment of critical facilities for the extreme temperature risk was not feasible for this update. Even so, it is apparent that the infrastructure that supports critical facilities that make up Community Lifelines are at risk from extreme temperatures, as demands on generation and distribution networks may overtax the system and result in failure. Finally, not all critical facilities have redundant power sources and may not even be wired to accept a generator for auxiliary heat or cooling. Future plan updates should consider including a more comprehensive examination of critical facility vulnerability to extreme temperatures, including those that have emergency heating or cooling equipment and those that may be wired to receive portable equipment.

65

A prolonged period of extremely cold temperatures can potentially cause significant impacts to providers of utilities, especially water and sewer services. Prolonged cold can result in pipe and water main breaks, which can cause severe damage. Cold weather resulted in a sprinkler system break at the University of Vermont in 2004, which caused $100,000 worth of damage. If a period of extreme cold is associated with power outages (after an ice storm, for example), Emergency Medical Services (EMS) may become strained as emergency responders try to relocate people who have no way to heat their homes. In early 2015, Chittenden County experienced several weeks of below freezing temperatures including several days below 0 degrees Fahrenheit. Several municipalities incurred substantial damage in terms of labor and equipment costs to repair frozen and/or broken sewer and water pipes.

Hazard Risk Ranking

Each jurisdiction in the Planning Area conducted a risk analysis to consider impacts, consequences (including magnitude/severity), and probability of future occurrences to determine the Overall Risk Rating for extreme temperatures.

Table 4.2.9: Extreme Temperatures Hazard Risk Rating Summary, All Municipalities

JURISDICTION	Sum - Impact/ Consequence Score	Probability	Total Risk Rating *(Impact/ Consequences x Probability)*	Hazard Ranking
Bolton	3	4	12	Low
Buels Gore	3	2	6	Low
Burlington	3	2	6	Low
Charlotte	5	4	20	Medium
Colchester				
Essex	2	4	8	Low
Essex Junction	2	4	8	Low
Hinesburg	3	4	12	Low
Huntington	2	4	8	Low
Jericho	4	4	16	Low
Milton	3	4	12	Low
Richmond	3	4	12	Low
Shelburne	5	4	20	Medium
South Burlington	3	4	12	Low
St. George	1	4	4	Low
Underhill	2	4	8	Low
Westford	4	5	20	Medium
Williston	7	4	28	Medium
Winooski	9	4	36	Medium
AVERAGE TOTAL RISK RATING SCORE			14.1	Low

The compilation of jurisdiction risk scores, along with consideration of the hazard profile and potential impacts and consequences, indicates that **extreme temperatures** is a **medium-risk** hazard for five municipalities, and a **low-risk** hazard for thirteen municipalities within the Planning Area. Consequently, a minimal vulnerability assessment is appropriate to identify the level of exposure to the municipalities within the Planning Area.

4.2.3 VULNERABILITY ANALYSIS

The entire planning area faces uniform susceptibility to the effects of extreme temperatures.

General Exposure

The exposure to extreme temperatures is primarily related to the impact on the population and direct economic loss if businesses are affected through temporary closures.

Potential Impacts of Climate Change

Climate change is projected to increase the frequency and intensity of extreme temperature events. Using global climate models and a high-resolution regional climate model, one study that investigated the link between extreme temperatures and global warming found a net increase in the number of days with environmental conditions that foster the development of extreme temperatures. This is true for much of the United States, including Chittenden County.

Public Input Related to Extreme Temperatures

A Public Hazard Survey made available to the public during the planning process indicated that approximately 0.84 percent of the more than 200 survey respondent households had directly experienced extreme temperatures within the previous five years. More than 66 percent were either slightly concerned or not concerned about impacts to people, businesses, or properties from extreme temperature events. On a ranking of the most important community assets, survey responders were most concerned about hospitals and other healthcare facilities, which have a moderately high risk to the impacts of extreme temperatures.

Opportunities for Mitigation

Preparedness and mitigation for extreme temperatures is more effective when a homeowner or business owner exercises personal initiative to take measures that protect his or her family members, employees, and property. Therefore, public education and awareness plays a significant role in such areas.

Factors for Consideration in the Next Planning Cycle

Future monitoring, evaluating, and updating of this plan should consider the following factors related to extreme temperature events as well as other information from the *VT SHMP* updates:

- Have extreme temperature events occurred since adoption of this plan?

- Has any new scientific research or methodology changed the ability to predict extreme temperature weather events or assess risk and vulnerability?
- Has there been any significant change in the population, built environment, community lifelines, natural environment, or economy that could affect the risk or vulnerability to extreme temperatures?
- Is there any new evidence related to the impact of climate change that could affect the level of risk or vulnerability to extreme temperature events?

SECTION 4.3: FLOODING

2022 MJAHMP Update
The hazard was reviewed and a new analysis was performed: • Reformatted hazard profile to improve flow, clarity, and graphic presentation. • Updated previous occurrences for number of events and losses. • Updated risk assessment and vulnerability analysis. • Updated data sources and imagery, where available. • Moved fluvial erosion information to separate hazard section to highlight specific risks and vulnerabilities related to that hazard. • Reviewed and re-evaluated hazard ranking using methodology described in **Section 4, Base Plan.**

Flooding						Overall Vulnerability
Definition, Key Terms, and Overview						High
Flood: an overflow of water onto normally dry land; the inundation of a normally dry area caused by rising water in an existing waterway -- a river, stream, or drainage ditch; ponding of water at or near the point where the rain fell. Flooding may last days or weeks and is a longer-term event than flash flooding. **Flash Flood**: A flood caused by heavy or excessive rainfall in a short period of time, generally less than six hours. Events are usually characterized by raging torrents after heavy rains that rip through riverbeds, urban streets, or mountain canyons sweeping everything before them. They can occur within minutes or hours of excessive rainfall, or even if no rain has fallen, such as after a levee or dam has failed, or after a sudden release of water by a debris or ice jam. **Lakeshore Flood:** the inundation of land areas along any of the lakes, including connecting lakes, over and above normal lake levels. This flooding may impact the immediate lakefront, bays, and interfaces between the lake and connecting waterways, such as rivers.						
Frequency	Probability	Potential Magnitude				
		Injuries/Deaths	Infrastructure	Environment		
Medium	**High**	Low	High	Medium		

4.3.1 HAZARD PROFILE

Flooding is a natural process that plays an important role in ecosystems by replenishing sediments and nutrients to soils that provide critical wildlife habitats; however, these benefits can become a serious threat in areas that have been substantially altered by human activity.

Flooding is a coast-to-coast threat to life, property, infrastructure, and the environment in the United States and is one of the most frequent and costly natural disasters. Between 1980 and 2021, 99 percent of the counties in the U.S. were impacted by a flood event. In addition, since

1980, flooding has resulted in almost $162 billion of damage in the U.S. and 624 deaths. Each flood event costs approximately $5 billion and occurs almost annually[66].

Floods cause two major types of damage:

- Water damage from inundation
- Erosion damage to property and infrastructure

Inundation flooding, the rise of riverine or lake water levels, is a naturally occurring event that is ranked as the second most significant natural hazard in Vermont in the *2018 Vermont State Hazard Mitigation Plan (VT SHMP)*. The primary types of inundation flooding include riverine, flash floods, and lakeshore floods. For the purpose of this plan update, a flood event resulting from excessive precipitation may result in one of these three types of flooding:

- **Riverine floods** - precipitation over a given river basin or body of water for a long period of time
- **Flash floods** - the product of heavy, localized precipitation in a short time period over a given location.
- **Lakeshore floods** – inundation of the lake shoreline and connecting waterways.

Riverine flooding occurs when heavy rainfall causes relatively high water levels in rivers or creeks to overtop the bank onto normally dry land. This type of flood event has occurred frequently in Chittenden County and its impacts have contributed significantly to the cost of this type of disaster in terms of human hardship and economic loss. A **flash flood** is a rapid inundation of low-lying areas, caused by heavy rain associated with severe thunderstorms, tropical systems, or melting water from ice or snow flowing over ice sheets or snowfields. Although flash floods can occur when the volume of water in a stream, creek or river channel overtops its banks, flash floods can also occur far away from bodies of water. Outside of waterways, they typically occur when a large volume of water is unable to be absorbed into the soil or carried away by stormwater systems quickly enough. Riverine flooding is generally slower to occur than flash flooding and frequently takes time to recede. This exposure to water for an extended period can lead to significant property damage.

Flash floods occur relatively frequently in the county and do not necessarily occur within floodplains. They could also result from a dam or levee failure within minutes or hours of heavy amounts of rainfall, or from a sudden release of water held by an ice jam. Most flash flooding is caused by slow-moving thunderstorms in a localized area or by heavy rains associated with hurricanes and tropical storms. Although flash flooding often occurs along mountain streams, it is also common in urbanized areas where more ground area is covered by impervious surfaces. Flash flood waters move at very high speeds and "walls" of water can reach heights of 10 to 20 feet. Flash floods are the cause of most flood-related deaths, and the accompanying debris can uproot trees, roll boulders, and damage or destroy buildings, bridges, and roads. Flash Flooding, as opposed to riverine flooding with a gradual onset, causes the largest amount of damage to property and infrastructure.

---

[66] National Centers for Environmental Information, "Billion-Dollar Weather and Climate Disasters". https://www.ncdc.noaa.gov/billions/summary-stats

Lakeshore flooding in Chittenden County occurs when floodwaters move quickly towards Lake Champlain from areas within the lake basin that are comprised of steep mountain slopes and narrow river valleys. The Lake Champlain Basin has a relatively wet climate, averaging 37.5 inches of precipitation throughout the year. Typically, more rain falls in the summer and autumn months and high-intensity storms are not uncommon with the effects of climate change beginning to be felt in the area. The intense rain events often result in flooding along river corridors and the shoreline of the lake. The Base Flood Elevation (BFE) of Lake Champlain established by the Federal Emergency Management Agency (FEMA) is 102.0 feet above sea level while flood stage established by the National Weather Service is 100 feet above sea level[67].

Two additional terms that relate to flooding characteristics are **Urban Flooding** and **Alluvial Fan Flooding**. Urban flooding occurs where man-made development has obstructed the natural flow of water and decreased the ability of natural groundcover to absorb and retain surface water runoff. Alluvial fan flooding can occur when inundation flooding impacts the surface of an alluvial fan or similar landform which originates at the apex and is characterized by high-velocity flows; active processes of erosion, sediment transport, and deposition; and unpredictable flow paths. Although flooding is the most common recurring hazard event in Vermont, data indicates that more than 75 percent of flood-related damages in the state, by dollars, are associated with fluvial erosion rather than inundation flooding[68], because "bank-full" conditions within river channels can contribute to the deposition of sedimentation, causing a build-up of alluvial fan type floodplains that do impact the Planning Area through sedimentation. Fluvial erosion is addressed in **Section 4.4** of this plan.

According to the *2018 Vermont State Hazard Mitigation Plan (VT SHMP),* inundation flooding typically follows, or is in combination with, one of the following events:

- **Rainfall**: Significant precipitation from rainstorms, thunderstorms, or hurricane/tropical storms. This can result in riverine or flash flooding when a large amount of rain occurs over a short period of time.
- **Snowmelt**: Rapidly warming temperatures lead to melted runoff, often exacerbated by heavy rainfall. The volume of water is based on snow depth and density.
- **Ice Jams**: Water flow in rivers or streams is blocked by ice accumulation, causing a riverine back-up. Warming temperatures and heavy rain cause snow to melt rapidly and frozen rivers to swell, resulting in flooding.

A late winter ice jam is caused by air temperatures rising above the freezing point which causes river ice to begin melting. On the undersurface of a river or lake, the action of turbulent flowing water causes a melt pattern. Eventually, if the ice cover is not subjected to a sudden increased flow, it may melt in place with little jamming or significant rise in water level. More likely, however, the ice may be moved and form ice jams. Additional rain and runoff from snowmelt in

[67] Lake Champlain Basin Program website. Retrieved at: https://www.lcbp.org/our-goals/thriving-communities/flooding/
[68] 2018 Vermont State Hazard Mitigation Plan, dated November 17, 2018, p. 55.

the spring also contributes to ice jam flooding. The increased flow raises the water level and may break ice loose from the banks. Because of the larger quantities of ice present, spring breakup jams are usually more destructive than jams that form as a result of water freezing in narrow stretches of rivers. Ice jams can break up and move downstream and reform, a process that may repeat itself several times.

Winter and spring snow melt, occasionally exacerbated by ice jams, are a significant source of flooding. Much of this flooding is flash flooding, occurring within hours of a rainstorm or other event.

Debris flows are not a specific type of flood, but a geological phenomenon that can impact flooding by producing masses of soil and fragmented rock that flow down a steep slope with heavy rainfall, and funnel into stream channels. Once combined with other objects, such as vegetative debris in their path, the resulting muddy and debris-laden deposit can exacerbate flood levels, property and infrastructure damage, and clean-up. Debris flows can be caused by natural processes such as decayed trees, broken tree limbs, logs, and abandoned beaver dams.

Floodplains (Special Flood Hazard Areas)

A floodplain is a flat land area adjacent to a river, creek or stream which is subject to periodic inundation by the body of water. In its most common usage, the floodplain most often refers to the area that is inundated by the “100-year” flood, or Special Flood Hazard Area (SFHA), the flood that has a 1 percent chance in any given year of being equaled or exceeded. Floodplains are made when floodwaters exceed the capacity of the main channel or escape the channel by eroding its banks. During inundation, silt drops from the retreating floodwater and, trapped by vegetation, tends to build up and level the floodplain surface. Buildup is greatest near the stream, forming natural levees in areas of stable banks. Floodplain deposits may show vertical size-graded stratification (sorting), tending to be coarser near the stream. The floodplain is an integral part of the stream system and is affected by the adjustments that the system makes to its sediment load and variable flow of water.

Natural floodplains have multiple functions associated with the natural or relatively undisturbed floodplain that moderate flooding, maintain water quality, recharge groundwater, reduce erosion, redistribute sand and sediment, and provide fish and wildlife habitats.

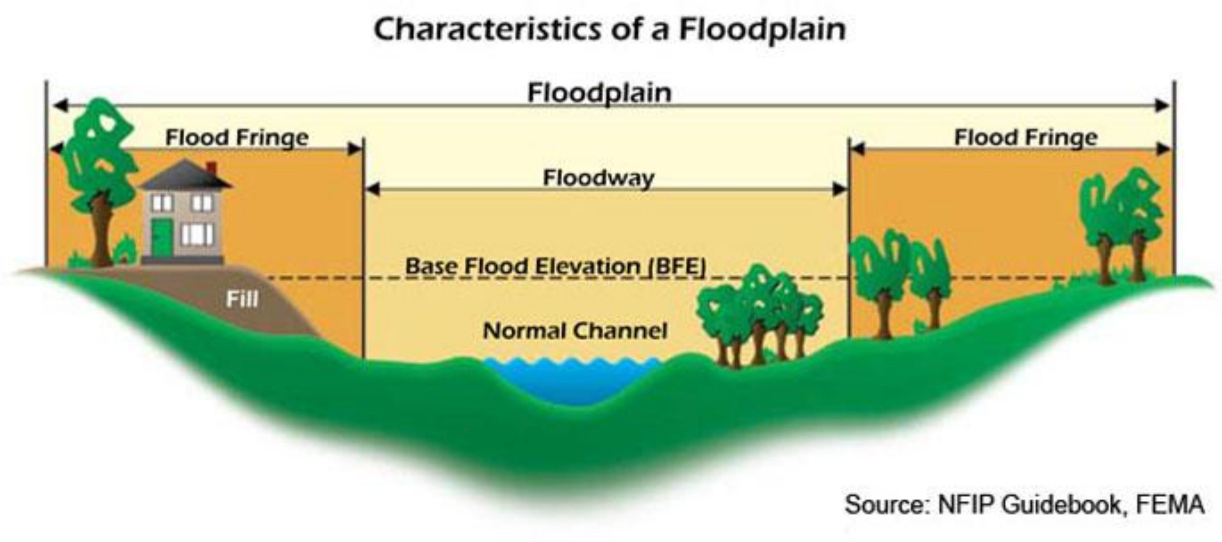


Figure 4.3.1: Characteristics of a Floodplain[69]

A SFHA floodplain and other areas subject to flooding, include:

- Areas subject to greater than the 1 percent annual chance flood, often referred to as the 100-year flood
- Areas subject to smaller, more frequent, or repetitive flooding
- Areas subject to shallow flooding, stormwater flooding, or drainage problems that do not meet the National Flood Insurance Program (NFIP) mapping criteria (but where 20 percent of flood insurance claims occur)
- Areas affected by flood-related hazards, such as coastal and riverine erosion
- Areas that will be flooded when future conditions are accounted for, such as sea level rise and upstream watershed development.[70]

The topographic floodplain includes the hydrologic floodplain and higher floodplains up to a defined elevation that corresponds to a specific flood frequency.

[69] National Flood Insurance Program (NFIP) Guidebook, FEMA.
[70] “No Adverse Impact How-To Guide for Mitigation”, American Society of Floodplain Managers, July 2013, Update 2016.

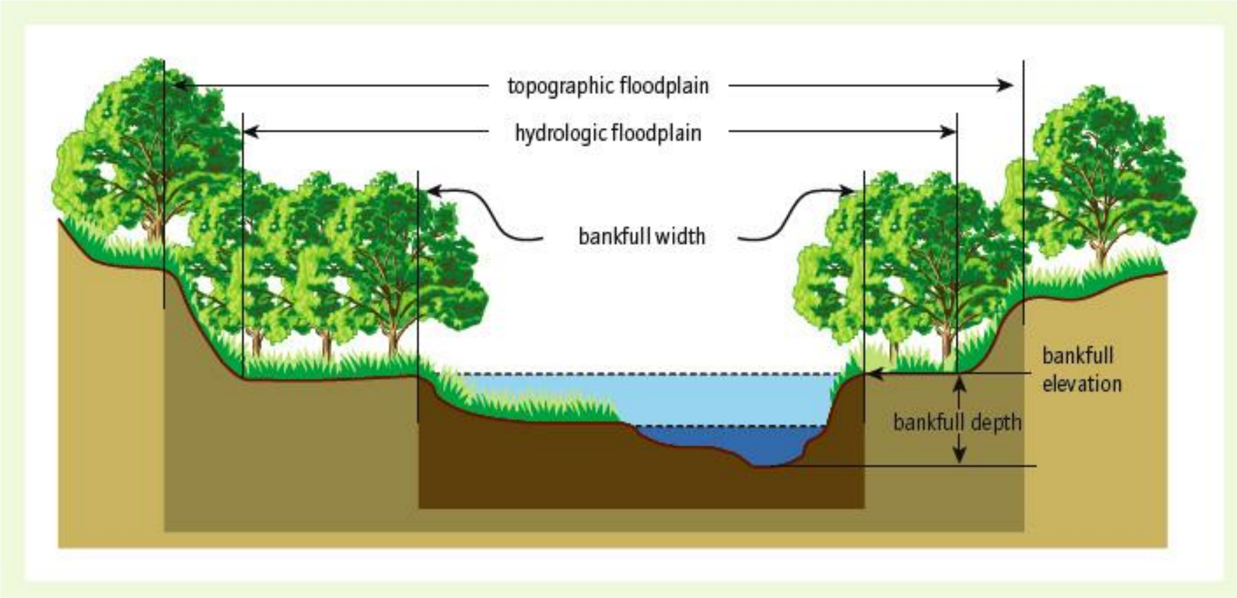


Figure 4.3.2: Topographic and Hydrologic Features of a Floodplain[71]

Some common examples of floodplains in Chittenden County include floodplains along major rivers, creeks and streams, and areas subject to flooding from ponding in low lying areas. Floodplains in the county are prone to relatively frequent flood inundation, due to high amounts of precipitation and subsequent run-off. When severe thunderstorms associated with hurricanes or tropical storms occur, they often result in floods in Chittenden County.

River Corridors

The area of land that a river accesses to meander and overtop its banks to release flood energy without excessive erosion is known as the River Corridor. The River Corridor is defined in Vermont statute as:

> *The land area adjacent to a river that is required to accommodate the dimensions, slope, planform, and buffer of the naturally stable channel and that is necessary for the natural maintenance or natural restoration of a dynamic equilibrium condition, as that term is defined in section 1422 of this title, and for minimization of fluvial erosion hazards, as delineated by the Agency of Natural Resources in accordance with river corridor protection procedures*[72]*.*

[71] U.S. EPA; https://cfpub.epa.gov/watertrain/moduleFrame.cfm?parent_object_id=637
[72] 10 V.S.A. Section 1428; https://legislature.vermont.gov/statutes/section/10/032/00752

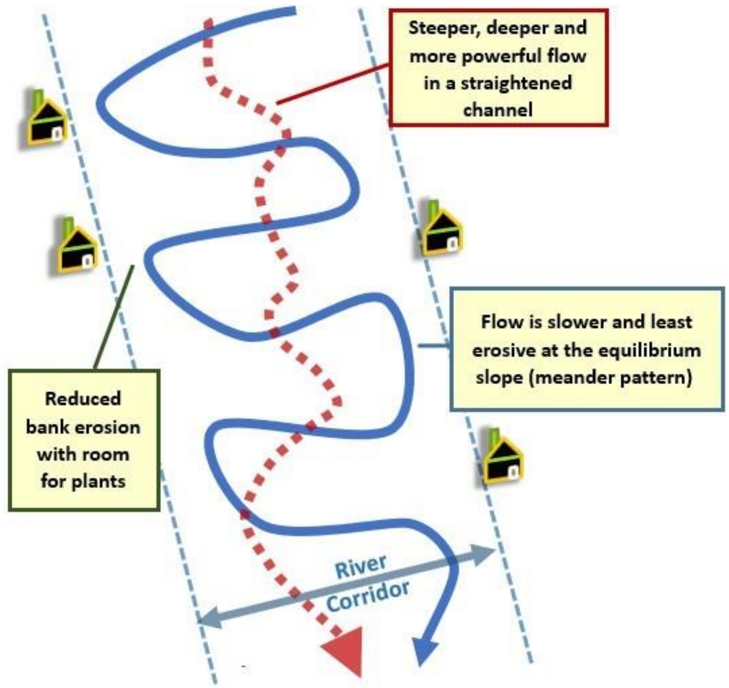


Figure 4.3.3: River Corridor Diagram[73]

Actions can be taken by municipalities to add protective measures to the River Corridors and surrounding areas, including land use development regulations that provide a floodplain or water resources overlay district to safeguard public health and safety and protect natural geomorphological processes and ecosystems. Multiple municipalities in the county have flood overlay districts.

Additional information about River Corridors is included in **Section 4.4, Fluvial Erosion**.

According to the *Chittenden County Flood Insurance Study*, dated July 2011, flooding on rivers, lakes, and streams in Chittenden County can occur during any season of the year, and are usually the result of heavy rainfall, snowmelts, and ice jams, sometimes in combination. Floods in late summer and fall are usually the result of above-normal precipitation. Winter floods result from the occasional thaws.

Flooding in Chittenden County is also frequently accompanied by trees, ice, and other debris being washed away and carried downstream to collect on bridges and other obstructions. If the

[73] Vermont Department of Environmental Conservation, Watershed Management Division, "Chittenden County Regional Planning Commission assisting municipalities with River Corridor planning", May 23, 2019; https://vtwatershedblog.com/2019/05/23/chittenden-county-regional-planning-commission-assisting-municipalities-with-river-corridor-planning/

flood flow increases, the debris piles can break loose and surge downstream along with a wall of water leading to other obstructions. Although it is difficult to predict the severity or location where debris may accumulate, obstructions in channels, such as bridges, fallen trees and debris accumulation, sharp turns in the channel, sediment build-up, and other impediments require monitoring to ensure that potential barriers do not constrict the flow of floodwater.

Table 4.3.1: Flood Hazard Profile Summary

<table>
<tr><td rowspan="8">Flood – HIGH RISK</td><td>Location</td><td>100- and 500- year floodplains; overbank and road flooding due to excessive rainfall; urban areas, rivers and stream valleys</td><td>Potential Cascading Effects</td></tr>
<tr><td>Extent</td><td>Life safety; major damage to buildings, property and environmental areas.</td><td rowspan="7">• Threat to health and safety
• Traffic/roadway damage/closures
• Resident/visitor/responder safety
• Disruption of critical services
• Increased security
• Major redirect of response operations/equipment
• Direct and indirect economic loss</td></tr>
<tr><td>Duration</td><td>Hours to multiple days</td></tr>
<tr><td>Probability</td><td>High</td></tr>
<tr><td>Seasonal Pattern</td><td>Summer, and increased duration of annual spring river flooding from snow melt</td></tr>
<tr><td>Speed of Onset</td><td>Moderate to rapid</td></tr>
<tr><td>Warning Time</td><td>Hours to days</td></tr>
<tr><td>Repetitive Loss</td><td>Tracked through NFIP data and municipal reports.</td></tr>
</table>

Location

There are numerous rivers and streams flowing through Chittenden County. When heavy or prolonged rainfall events occur, these rivers and streams are susceptible to some degree of flooding. In addition, the shoreland along Lake Champlain can be impacted by flooding.

Significant waterways and bodies of water in Chittenden County include:

- Browns River
- Huntington River
- Lamoille River and its tributaries
- LaPlatte River
- Lee River
- Winooski River
- Lake Champlain
- Shelburne Bay

Significant floodplain areas include the Lamoille, LaPlatte, and Winooski Rivers. The identified floodplain does not consider areas that might be inundated in the case of dam failure. Green Mountain Power, which owns several of the dams on the Winooski River, maintains maps of areas that would be inundated in a dam failure, and the state has similar maps for state-owned dams, both in Chittenden County and upstream on the Winooski River. Formal flood hazard areas have been mapped in all the county's municipalities except Buels Gore which has no documented 100-year floodplains. A good portion of this area consists of the shoreland of Lake Champlain. Individual maps related to River Corridors and floodplains are presented in the jurisdiction annexes.

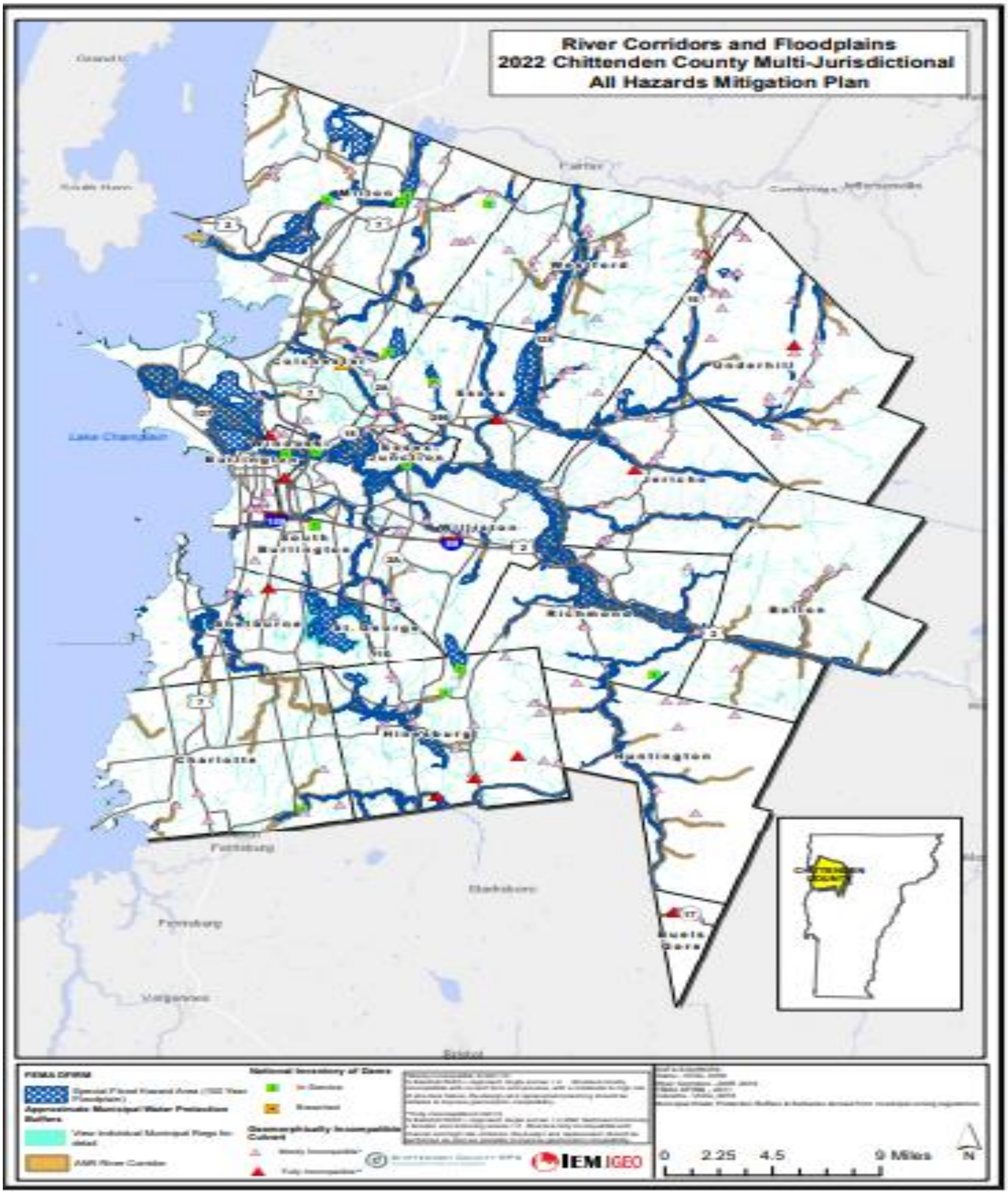


Figure 4.3.4: River Corridors and FEMA Special Flood Hazard Areas (SFHA) in Chittenden County[74]

[74] Flood Insurance Rate Maps (FIRMs), National Flood Insurance Program

In addition to floodplains identified by Flood Insurance Rate Maps (FIRMs), some areas are more susceptible to flash floods, particularly alluvial fans where streams transition between steep mountain grades to flatter valleys; urban areas with more impervious surfaces; roadways; stormwater run-off areas; and narrow stream channels. Mountainous areas in Chittenden County are particularly prone to flash flooding due to steep terrain. Exact locations impacted by these events are tracked at the municipal levels and additional information is provided in the jurisdictional annexes.

The 2018 *VT SHMP* identifies the locations of greatest vulnerability within Chittenden County as Bolton, Huntington, Richmond, Underhill, and Westford, due to steep roads vulnerable to both flooding and fluvial erosion.[75]

Extent

Because floods can occur for many reasons, not all floods are equal in magnitude, duration, or effect. The strength or magnitude of flooding varies greatly depending on multiple meteorological, environmental, and geological factors such as latitude, altitude, topography, and atmospheric conditions. In addition, there is seasonal variation in severe weather events which influence a storm's characteristics, warning time, speed of onset, and duration. Most floods are preceded by a warning period of variable length which allows for some level of preparedness, and duration can last from minutes to hours, or even to multiple days in extreme events.

The extent of a flood event is determined by the following:

- A combination of stream and river basin topography and physiography
- Precipitation and weather patterns
- Recent soil moisture conditions
- The degree of vegetative clearing and built development.

Several tools assist local officials in predicting potential flood conditions and issuing timely warnings, including the stream gage systems on the county's creeks and rivers. Monitored by the Advanced Hydrological Prediction Center, United States Geological Survey (USGS), United States Army Corps of Engineers (USACE), and the National Weather Service, the gages closely follow the rise and fall of water levels and can provide a close estimate of water levels and timing for preparing for or evacuating in advance of a potential flood.

[75] *2018 Vermont State Hazard Mitigation Plan*, dated November 17, 2018, page 51.

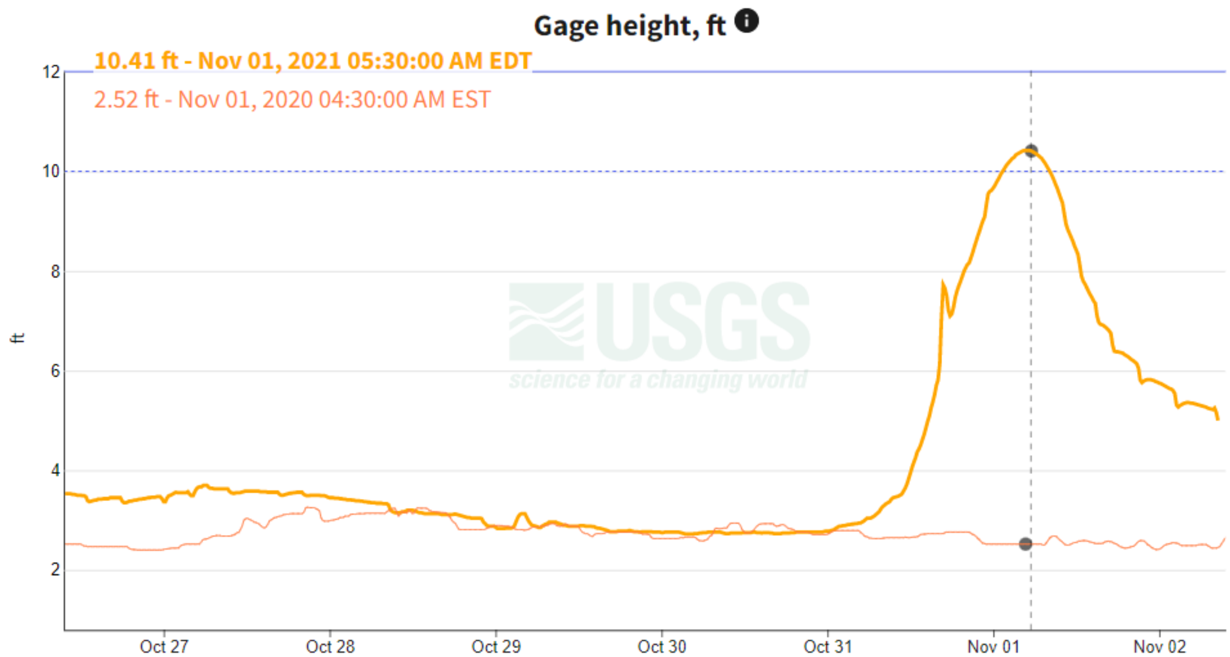


Figure 4.3.5: Winooski River Real-Time Streamflow Gage Height, in feet[76]

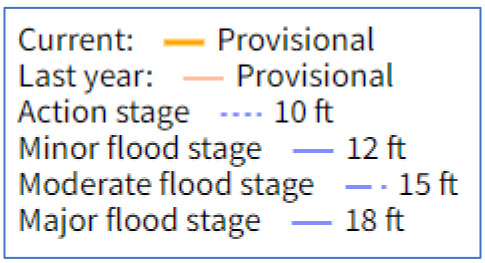


Figure 4.3,5 - Winooski River Flood Stage Indicators

The Winooski River gage data illustrates real-time monitoring of water levels provided by the stream gage network. In this example, the water level in the Winooski River exceeded the Action Stage of 10 feet on November 1, 2021; however, the level dropped within twenty-four hours, indicating that streamflow was sufficient to quickly reduce the water volume below the Action Stage level.

The gage on the Winooski River has been in operation for more than 89 years; however, its measurements are severely influenced by the operation of other upstream dams. The major 1927 flood (which occurred prior to dam construction) still has the greatest record flow of 113,000 cubic feet per second (CFS). The 1933 and 1934 flows were also unobstructed by dams and registered flows in the 30,000+ CFS range. As a comparison, the most recent flood event, high flows caused by Tropical Storm Irene in August 2011, registered at 35,000 CFS.

Previous Occurrences

The National Oceanic and Atmospheric Administration's (NOAA), National Centers for Environmental Information (NCEI) documents flooding events for Chittenden County in its Storm Events Database. Events range widely in terms of location, magnitude, and impact. The most frequent flooding events are localized and result from heavy rains in a short period of time over urbanized areas that are not able to adequately handle storm water runoff.

[76] USGS, https://waterdata.usgs.gov/monitoring-location/04290500/#parameterCode=00065&period=P7D&compare=true

The Storm Events Database (under categories for flood, flash flood, and lakeshore flood) documents **75 flood events** in Chittenden County between 1950 and June 30, 2021, with nine (9) of these events occurring since 2017.

Table 4.3.2. Total Impact of Flood-Related Hazards in Chittenden County, 1950 to June 2021[77]

Flood Type	Cause	Number of Events	Property Damage*	Crop Damage*
Flash Flood	[Not Available]	16	$4,355,000	0
	Heavy Rain	14	$6,580,000	0
	Heavy Rain/Tropical System	1	$2,000,000	$1,000,000
ALL FLASH FLOOD		**31**	**$12,935,000**	**$1,000,000**
Flood	[Not Available]	19	$909,000	0
	Heavy Rain	5	$3,420,000	$1,050,000
	Heavy Rain/Snow Melt	3	$818,000	
	Ice Jam	2	$10,000	0
ALL FLOOD		**39**	**$4,238,000**	**$1,050,000**
Lakeshore Flood	[Not Available]	**5**	**$5,520,000**	**0**
TOTAL – Flash Flood, Flood, Lakeshore Flood		**75**	**$22,693,000**	**$2,050,000**

These events have resulted in one death, in 2011, and caused millions of dollars in damages to property and crops; however, most events did not result in an emergency or disaster declaration, so additional details related to these events is limited.

Other than mapped floodplains, there is little formal recording or mapping of areas with an above-average frequency of occurrence. One useful method for understanding the type and frequency of hazard events is to examine damages occurring in previously declared Federal disasters.

Between 1964 and 2021, **13 flood events** in Chittenden County have been significant enough to be included in Federal Disaster Declarations. There have been **five** federal declarations for flood that included Chittenden County since the last plan update in 2017:

Information related to the FEMA-obligated funding under the Public Assistance (PA) program for federally-declared disasters is unavailable prior to 2001.

[77] National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database for January 1, 1950 to June 30, 2021. Damage costs presented in year of occurrence values, as reported by the NCEI.

Table 4.3.3: Flood Disaster Declarations in Chittenden County (1973 - 2021)[78]

Disaster Number	Event Type Individual Assistance (IA) Public Assistance (PA)	Declaration Date	Damage Amount
EM-3567	***Tropical Storm Henri (14 counties)***	08/22/2021	[Not yet Determined]
DR-4474-VT	***Severe Storms and Flooding (8 counties)*** ***Chittenden - PA***	06/14/2019	FEMA Obligated Dollars as of 04/28/2022 PA - $16,405,211.45 HMGP Obligated - $187,392.37
DR-4380-VT	***Severe Storms and Flooding (5 counties)*** ***Chittenden - PA***	07/30/2018	FEMA Obligated Dollars as of 05/25/2021 PA - $3,246,787.21 HMGP Obligated - $169,020.79
DR-4356-VT	***Severe Storms and Flooding (10 counties)*** ***Chittenden - PA***	01/02/2018	FEMA Obligated Dollars as of 05/25/2021 PA - $5,296,752.57 HMGP Obligated - $122,528,55
DR-4330-VT	***Severe Storms and Flooding (7 counties)*** ***Chittenden - PA***	08/16/2017	FEMA Obligated Dollars as of 10/28/2020 PA - $11,716,952.15 HMGP Obligated - $593,310.75
DR-4232-VT	***Severe Storm and Flooding (2 counties)*** ***Chittenden - PA***	07/29/2015	FEMA Obligated Dollars as of 03/20/2020 PA - $1,226,279.93
DR-4140-VT	***Severe Storms and Flooding (7 counties)*** Chittenden - PA	08/02/2013	FEMA Obligated Dollars as of 08/24/2021 PA- $6,296,981.81
DR-4120-VT	***Severe Storms and Flooding (3 counties)*** Chittenden - PA	06/13/2013	FEMA Obligated Dollars as of 03/20/2020 PA-$1,914,682.79
DR-1559-VT	***Vermont Severe Storms and Flooding (7 counties)*** Chittenden - PA	09/23/2004	FEMA Obligated Dollars as of 03/20/2020 PA-$2,348,737.81
EM-3167[79]	***Vermont Snowstorm (9 counties)*** Chittenden – PA (Cat. B only)	04/10/2001	FEMA Obligated Dollars as of 03/20/2020 PA (Cat. B) - $1,296,992.34
DR-1228-VT	***Vermont Severe Storms and Flooding (11 counties)*** Chittenden – IA, PA	06/30/1998	[Not Available]
DR-1201-VT	***Vermont Severe Ice Storms, Rain, High Winds and Flooding (6 counties)***	01/15/1998	[Not Available]

[78] Federal Emergency Management Agency (FEMA)
[79] EM-3167 was declared for a snowstorm leading to snow melt and associated runoff due to the spring melt that resulted in lakeshore flooding on Lake Champlain continuing into May, 2001.

Disaster Number	Event Type Individual Assistance (IA) Public Assistance (PA)	Declaration Date	Damage Amount
	Chittenden – IA, PA		
DR-1101-VT	***Vermont Storms and Flooding (11 counties)*** Chittenden - PA	02/13/1996	[Not Available]
DR-1063-VT	***Vermont Heavy Rain, Flooding (6 counties)*** Chittenden – IA, PA	04/16/1995	[Not Available]
DR-990-VT	***Vermont Flooding, Heavy Rain, Snowmelt (4 counties)*** Chittenden - PA	05/12/1993	[Not Available]
DR-938-VT	***Vermont Flooding, Heavy Rain, Ice Jams (5 counties)*** Chittenden - IA, PA	03/18/1992	[Not Available]
DR-875-VT	***Vermont Flooding, Severe Storm (5 counties)*** Chittenden - PA	07/25/1990	[Not Available]
DR-518-VT	***Vermont Severe Storms, High Winds, Flooding (12 counties)*** Chittenden - IA, PA	08/05/1976	[Not Available]
DR-397-VT	***Vermont Severe Storms, Flooding, Landslides (14 counties)*** Chittenden – IA, PA	07/06/1973	[Not Available]

Vermont experienced major floods long before Federal disaster assistance became available. The most destructive recorded event was in November 1927. In the month before flooding occurred, rains in excess of 150 percent of normal precipitation fell after the ground had frozen. The flood itself was preceded by 10 inches of rain falling over the course of a few days. The flood inundated parts of many towns and damaged or destroyed numerous bridges in the county. As the historical reports of this event indicate, the geography and topography of Vermont are conducive for a significant localized storm with extreme damage at almost any location.

Lake Champlain

Lake Champlain has reached flood stage during the spring months three times in the last twenty-one years, notably in 2000, 2007, and, most significantly, in 2011, inundating low-lying areas including lakeside homes and infrastructure such as the King Street Ferry Dock in Burlington. The highest recorded crest of 103.27 feet was documented on May 6, 2011. The highest crest since 2017 was 100.99 feet, recorded on April 29, 2019, making it the fourth highest crest on record.

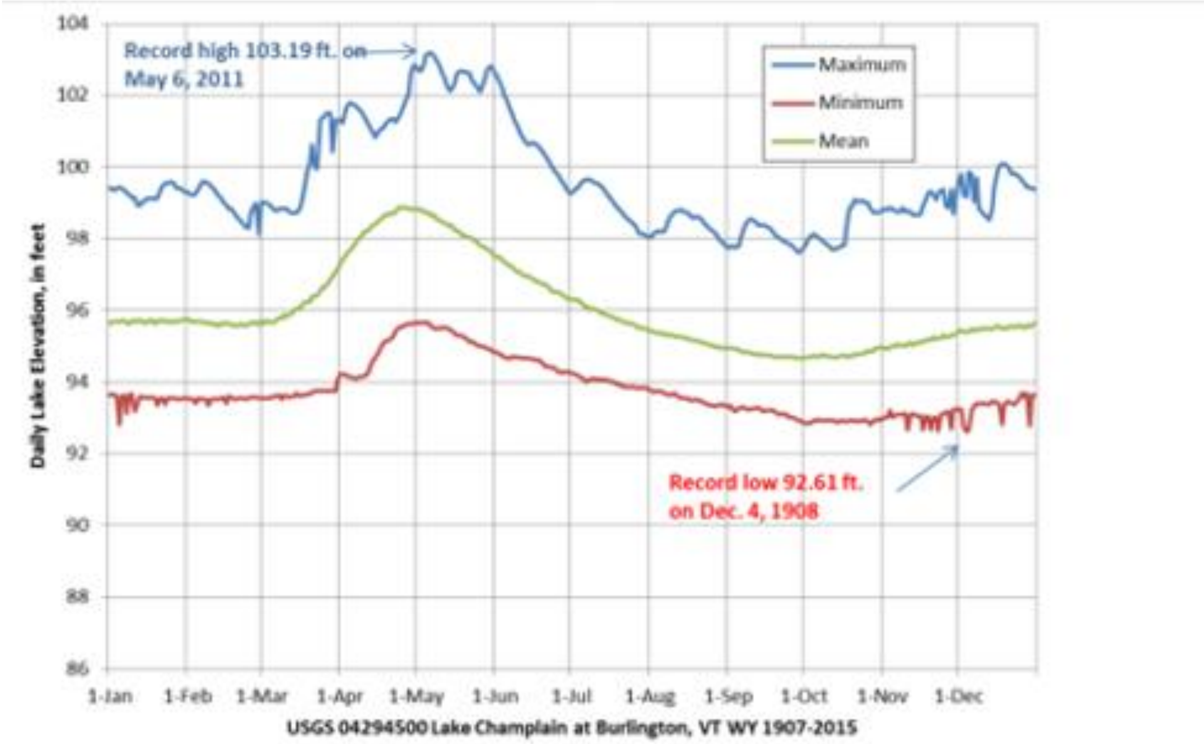


Figure 4.3.6: Lake Champlain Water Levels at Burlington, VT, May 6, 2011[80]

Table 4.3.4: Lake Champlain Flood Categories and Related Impacts[81]

Category	Lake Level (in feet)	Impacts
Major Flood Stage (*Base Flood Elevation (BFE) established by FEMA)*	101.5	• Severe flooding occurs with widespread inundation of lakeside properties and closure of low-lying roads.
Moderate Flood Stage	101	• Flooding becomes serious and enters lake front properties and inundates low-lying roads, piers, and docks. • Wave erosion on windward shores becomes a problem. • If lake ice is present, structural damage can occur.
Flood Stage *(Established by National Weather Service)*	100	• Water begins to enter some lake front properties and threaten low lying roads, piers, and docks. • Wave action can compound flooding on windward facing shorelines
Action Stage	99.9	• Owners or vulnerable properties are instructed to take measures to protect lives and property.

80 National Weather Service, Advanced Hydrologic Prediction Service; 2017 Chittenden County, VT, Multi-Jurisdictional All-Hazards Mitigation Plan, dated March 6, 2017
81 National Weather Service, Advanced Hydrologic Prediction Service; 2017 Chittenden County, VT, Multi-Jurisdictional All-Hazards Mitigation Plan, dated March 6, 2017

Low levels recorded on the lake also indicate dry periods related to drought conditions. The winter of 2015-2016 experienced relatively little snowfall and the summer of 2016 was relatively dry in terms of rainfall. Water levels in Lake Champlain dropped quite low in the fall of 2016 almost matching the record low of 1908 with a peak trough of 93.26 feet on both October 16-17 before climbing back to 94 feet on October 31.

Tables 4.3.5 through 4.3.7 illustrate total repair costs incurred by municipalities as documented under Public Assistance projects supported by FEMA for disaster recovery.

Table 4.3.5: Public Assistance Funding for Federal Disaster Declarations in Chittenden County, 1990 to 1999[82]

Jurisdiction	June 1990	March 1992	April 1993	August 1995	January 1996	January 1998	July 1998	Total
	DR-875	DR-938	DR-990	DR-1063	DR-1101	DR-1201	DR-1228	
	Flood	Flood	Lake Flood	Flood	Flood	Ice Storm	Flood	
Bolton	$1,282,529	-	-	-	$29,400	-	$37,435	**$1,349,364**
Buels Gore	-	-	-	-	-	-	-	**--**
Burlington	-	-	$177,810	-	-	$1,338,080	$94,161	**$1,610,051**
Charlotte	-	-	$5,208	-	$7,647	$149,603	-	**$162,458**
Colchester	-	-	$336,961	-	$32,184	$226,747	$124,477	**$720,369**
Essex	-	-	-	-	$88,341	$63,056	-	**$151,397**
Essex Junction	-	-	-	-	-	$22,287	-	**$22,287**
Hinesburg	$17,275	-	-	-	$13,058	$34,952	$10,152	**$75,437**
Huntington	$3,111	-	-	-	$11,333	-	-	**$14,444**
Jericho	$313,774	-	-	-	$13,030	-	-	**$326,804**
Milton	$21,399	$21,795	-	-	$100,887	$85,384	$29,601	**$259,066**
Richmond	$145,058	$7,124	-	-	$31,586	-	$9,652	**$193,420**
Shelburne	-	-	$13,115	-	-	$171,662	$32,843	**$217,620**
S. Burlington	-	-	$3,070	-	-	$141,856	$33,749	**$178,675**
St. George	-	-	-	-	-	$2,1519	-	**$2,519**
Underhill	$55,626	-	-	$228,075	$9,434	-	$124,477	**$650,700**
Westford	$37,658	-	-	-	$44,494	-	$389,279	**$471,431**
Williston	-	-	-	-	$12, 507	$21,163	-	**$33,670**
Winooski	-	-	-	-	-	$76,088	-	**$76,088**
TOTALS	**$1,876,430**	**$28,919**	**$536,164**	**$228,075**	**$393,901**	**$2,333,397**	**$1,118,914**	**$4,639,370**

[82] Vermont Department of Housing & Community Affairs; Vermont Agency of Transportation. Dollar value figures represent the total estimated repair costs for damages suffered to municipal resources. This table represents the most recent data available at the time of this update and does not include damage claims submitted to FEMA by non-municipal organizations or by private individuals or businesses.

Between 1990 and 2021, each town within the planning area had a Federally declared disaster; however, further analysis reveals some differences between various areas of the county. The four non-lakeshore floods from 1990 through 1996 primarily affected the more upland municipalities, the gravel and dirt roads of which were vulnerable to washout. The unique flooding in July of 1998, caused by a rare combination of heavy summer rains falling on ground still saturated from a January ice storm and subsequent snowfall, affected both metropolitan and rural communities. Excluding the two somewhat anomalous events of the lakeshore flooding of 1993 (caused by a confluence of extremely high lake levels and strong onshore winds) and the July 1998 flooding (aggravated by saturated soil from the January Ice Storm), the urban and suburban communities of the county with their paved roads, lack of significant hills or small mountains and more developed stormwater systems, suffered flood damages less often and less severely. The lowland distribution of the 1998 Ice Storm is evident. Municipalities in the hills and mountains of the county had temperatures below the freezing point during that event. Since 2010, the region incurred very little damage related to flood. Comparing the time period before 2010 to more recent history, the upland towns suffered no damages from flood or rain events.

Table 4.3.6: Public Assistance Funding for Federal Disaster Declarations in Chittenden County, 2010-2016[83]

Jurisdiction	December 2010	June 2011	September 2011	June 2013	August 2013	January 2015	February 2015	July 2015	Total
	DR-1951	DR-1995	DR-4022	DR-4120	DR-4140	DR-4163	DR-4207	DR-4232	
	Severe Storm	Flood	Tropical Storm	Flood	Flood	Ice Storm	Ice Storm	Flood	
Bolton		-	$37,046	$105,950	-	$25,702	-	$334,128	**$502,826**
Buels Gore	-	-	-	-	-	-	-	-	**-**
Burlington	-	$5,394	$6,032	$57,241	$20,552	-	-	-	**$89,219**
Charlotte	-	-	-	-	-	-	-	-	**-**
Colchester	-	$862,089	-	$4,817	-	-	-	-	**$866,906**
Essex	$44,854	$70,669		$260,650	$21,923	$5,114	-	-	**$403,210**
Essex Junction	$1,329	-	-	-	-	-	-	-	**$1,329**
Hinesburg	$5,627	-	-	-	$71,871	-	$90,000	-	**$167,498**
Huntington	-	$151,252	$128,104	-	$331,838	-	$140,000	$138,232	**$889,426**
Jericho	$4,452	$90,786	-	$75,342	$237,940	-	-	-	**$408,520**
Milton	-	$16,675	$46,440	-	$8,959	$14,315	-	$8,000	**$94,389**
Richmond	$1,113	$52,442	$124,16	-	$137,906	-	$20,000	$225,923	**$561,553**
Shelburne	-	$39,980	-	-	-	-	-	-	**$39,980**
S. Burlington	-	$5,394	$6,032	$57,241	$20,552	-	-	-	**$89,219**
St. George	-	-	-	-	-	-	-	-	**-**

[83] Vermont Department of Housing & Community Affairs; Vermont Agency of Transportation. Dollar value figures represent the total estimated repair costs for damages suffered to municipal resources. This table does not include damage claims submitted to FEMA by non-municipal organizations or by private individuals or businesses.

Jurisdiction	December 2010	June 2011	September 2011	June 2013	August 2013	January 2015	February 2015	July 2015	Total
	DR-1951	DR-1995	DR-4022	DR-4120	DR-4140	DR-4163	DR-4207	DR-4232	
	Severe Storm	Flood	Tropical Storm	Flood	Flood	Ice Storm	Ice Storm	Flood	
Underhill	-	$101,217	-	$312,358	$23,388	-	-	$4,654	**$441,617**
Westford	$9,053	$5,631	-	$602,193	-	$47,350	$14,000	-	**$678,227**
Williston	$42,343	$43,311	$3,803	$78,415	$245,236	-	-	-	**$413,108**
Winooski	-	-	-	-	-	-	-	-	**-**
TOTALS	**$125,829**	**$2,371,508**	**$439,632**	**$1,424,399**	**$1,144,506**	**$68,375**	**$264,000**	**$710,937**	**$6,649,186**

Table 4.3.7: Public Assistance Funding for Federal Disaster Declarations in Chittenden County, 2017-2021

Jurisdiction	October 2017	May 2018	November 2019	Total
	DR-4356	DR-4380	DR-4474	
	Severe Storms & Flood	Severe Storms & Flood	Severe Storms & Flood	
Bolton	-	**$108,122**	**$449,137**	**$557,259**
Buels Gore	-	-	-	**-**
Burlington	-	-	**$25,399**	**$25,399**
Charlotte	-	-	**$72,153**	**$72,153**
Colchester	-	-	-	
Essex	**$72,604**	-	**$126,775**	**$199,379**
Essex Junction	-	-	**$1,371,390**	**$1,371,390**
Hinesburg	-	-	**$19,980**	**19,980**
Huntington	-	-	**$47,505**	**$47,505**
Jericho	**$10,726**	-	-	**$10,726**
Milton	**$27,490**	-	**$9,213**	**$36,703**
Richmond	**$11,103**	**$172,328**	**$467,295**	**$650,726**
Shelburne	-	**$28,442**		**$28,442**
S. Burlington	-	-	**$18,460**	**$18,460**
St. George	-	-	-	**-**
Underhill	**$24,869**	-	**$48,641**	**$73,510**
Westford	**$17,736**	-	**$60,762**	**$78,498**
Williston	-	**$40,215**	**$53,127**	**$93,342**
Winooski	-	-	-	**-**
TOTALS	**$164,528**	**$349,107**	**$2,769,837**	**$3,283,472**

Probability of Future Occurrences

Flooding remains a highly likely occurrence throughout the identified flood hazard areas of the municipalities within Chittenden County.

Periodic flooding of lands adjacent to rivers, streams, and shorelines (land known as floodplains) is a natural occurrence that can be expected to take place based upon multiple methods of calculating probability during any given year. While each method provides one source of information to support risk reduction investments, and may appear to be inconsistent with other probability measurements each tool should be considered to inform risk-based decision making while increasing risk awareness.

Annual probability has been calculated based on the annual chance of occurrence for a 100-year flood. A 100-year flood is not a flood that occurs every 100 years. In fact, the 100-year flood has a 26 percent chance of occurring during a 30-year period, the typical length of many mortgages. The 100-year flood is a regulatory standard used by Federal agencies, states, and NFIP-participating communities to administer and enforce floodplain management programs. The 100-year flood is also used by the NFIP as the basis for insurance requirements nationwide. The Flood Insurance Rate Maps (FIRMs) base recurrence intervals as indicated by annual probability.

Table 4.3.8: Annual Probability Based on Flood Return Period[84]

Flood Recurrence Interval	Annual Chance of Occurrence
10 - year	10.0%
50 - year	2.0%
100 – year	1.0%
500 - year	0.2%

Another method of calculating probability is through determining the return rate based on previous occurrences. The recurrence interval of a flood is defined as the average time interval, in years, expected between a flood event of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence intervals. Using this method, the number of years of record (70.5) was divided by the number of occurrences (75) in Chittenden County, resulting in a simple past-determined recurrence interval of 0.94 percent.

The **National Risk Index (NRI)** also provides an annualized frequency value for multiple natural hazards, including riverine flooding. The NRI calculation of 2.4 events per year is based on 58 events on record over a period of 24 years (1996-2019)[85].

Conditions related to climate change may increase the number and severity of intense precipitation events in the future, creating higher levels of inundation and storm water run-off which exacerbates flood events that occur in locations not previously impacted.

[84] Flood Insurance Rate Maps, National Flood Insurance Program
[85] National Risk Index, Retrieved at: https://www.fema.gov/flood-maps/products-tools/national-risk-index

National Flood Insurance Program (NFIP)

The Flood Insurance and Mitigation Administration (FIMA), a component of FEMA, manages the NFIP, which includes three components:

1. Flood Insurance
2. Floodplain Management
3. Flood Hazard Mapping

Participating municipalities adopt and enforce floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. Community participation in the NFIP is voluntary.

Flood insurance is designed to provide an alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. Flood damage is reduced by nearly $1 billion a year through communities implementing sound floodplain management requirements and property owners purchasing flood insurance. Additionally, buildings constructed in compliance with NFIP building standards suffer approximately 80 percent less damage annually than those not built to comply with the standards.

In addition to providing flood insurance and reducing flood damages through floodplain management regulations, the NFIP identifies and maps the Nation's floodplains. Mapping flood hazards creates broad-based awareness of flood hazards, and provides the data needed for floodplain management programs and to actuarially rate new construction for flood insurance. Beginning October 1, 2021, the NFIP revised its premium pricing methodology to deliver rates that are “actuarially sound, equitable, easier to understand and better reflect an individual property’s flood risk”[86].

As of March 17, 2022, there was a total of 281 flood insurance policies in-force in the Chittenden County planning area, a slight drop since the previous plan. These policies amounted to more than $294,717 in flood insurance premiums paid in the region. Approximately 204 claims have been filed, accounting for more than $2.6 million in payments.

Floodplain management regulations are the cornerstone of NFIP participation. Communities that participate in the NFIP are expected to adopt and enforce floodplain management regulations. These regulations apply to all types of floodplain development and ensure that development activities will not cause an increase in future flood damages. Buildings are required to be elevated at or above the Base Flood Elevation (BFE).

Community Rating System

Local municipalities receive a benefit by participating in the Community Rating System (CRS), as defined in the state’s Emergency Relief and Assistance Fund (ERAF) rule to protect River

[86] Release Number HQ-21-217, dated September 24, 2021, Federal Emergency Management Administration. https://www.fema.gov/press-release/20210924/fema-offers-more-equitable-flood-insurance-rates-beginning-oct-1

Corridors. Under the ERAF, eligible communities that have adopted the National Flood Insurance Program (NFIP), Town Road and Bridge Standards, Local Emergency Operations Plans, and Local Hazard Mitigation Plans receive 12.5 percent reimbursement rate from the State of Vermont for local costs related to Federal Public Assistance. If the community protects its flood hazard areas from new encroachments and participates in the CRS, it qualifies for the state to pay 17.5 percent of the local costs.

The Town of Colchester (which is not a participating jurisdiction in the 2022 *Chittenden County MJAHMP* update) is the only municipality within Chittenden County currently participating in the Community Rating System, with a Class Rate of 8, indicating a 10 percent savings for property insurance premiums for local property owners.

Repetitive Loss Properties and Severe Repetitive Loss Properties

A Repetitive Loss Property is "any NFIP-insured property that, since 1978 and regardless of any change(s) of ownership during that period, has experienced: a) four or more paid flood losses; or b) two paid flood losses within a 10-year period that equal or exceed the current value of the insured property; or c) three or more paid losses that equal or exceed the current value of the insured property." Nationwide, Repetitive Loss properties constitute two percent of all NFIP insured properties but are responsible for 40 percent of all NFIP claims. Mitigation for Repetitive Loss properties is a high priority for FEMA, and the areas in which these properties are located typically represent the most flood prone areas of a community.

A second category of Repetitive Loss properties has been identified for those properties that have sustained the highest levels of damages and claims; these are known as Severe Repetitive Loss properties. Severe Repetitive Loss properties are defined as any building that is covered under a Standard Flood Insurance Policy (SFIP) and has sustained flood damage for which: (a) four or more separate claim payments have been made under a SFIP, with the amount of each claim exceeding $5,000, and with the cumulative amount of such claims exceeding $20,000; or (b) at least two separate claims payments have been made under a SFIP, with the cumulative amount of those payments exceeding the fair market value of the insured structure as of the day before the loss.

The identification of Repetitive Loss properties is an important element to conducting a local flood risk assessment, as the inherent characteristics of properties with multiple flood losses strongly suggest that they will be threatened by continual losses. Repetitive Loss properties are also important to the NFIP, since structures that flood frequently put a strain on the National Flood Insurance Fund.

A primary goal of FEMA is to reduce the number of structures that meet these criteria, whether through elevation, acquisition, relocation, or a flood-control project that lessens the potential for continual losses.

According to FEMA, there are currently **15 Repetitive Loss properties and no Severe Repetitive Loss Properties** within Chittenden County's municipalities. Since 1978, there are 201 claims represented by these properties, with a total claims value of $2,621,869. The specific addresses of the properties are maintained by FEMA, but are omitted from this Plan, as required by law. However, Table 5.7 in Section 5-Capabilities Assessment provides list of repetitive loss properties by type by municipality. **Table 4.3.9: Chittenden County Communities Participating in the NFIP, and Repetitive Loss Properties, as of March 17, 2022**[87]

Jurisdiction	Date of FIRM	Number of Policies	Total Premiums (in dollars)	Total Coverage (in dollars)	Total Number of Claims Since 1978	Value of Claims Paid Since 1978 (in dollars)	Number of Repetitive Loss Properties	Number of Severe Repetitive Loss Properties
Bolton	8/4/2014	13	$14,630	$2,787,700	6	$126,117	0	0
Buels Gore	*Not Applicable*							
Burlington	7/18/2011	35	$34,842	$10,640,200	14	$110,146	0	0
Charlotte	7/18/2011	11	$15,524	$3,750,00	5	$135,095	0	0
Colchester	7/18/2011	37	$21,304	$10,948	61	$970,283	3	0
Essex Junction	7/18/2011	7	$3470	$1,568,000	0	0	0	0
Essex	7/18/2011	12	$12,310	$4,109,400	3	$6,877	0	0
Hinesburg	8/4/2014	3	$1,653	$676,000	3	$3,444	0	0
Huntington	8/4/2014	21	$3,832	$5,977,500	17	$156,573	2	0
Jericho	8/4/2014	14	$8,941	$3,239,000	7	$62,628	1	0
Mitton	7/18/2011	16	$25,900	$3,697,900	23	$298,553	2	0
Richmond	8/4/2014	51	$72,435	$14,103,300	41	$505,951	6	0
St. George*	8/4/2014	St. Gorge joined the NFIP in October 2021						
Shelburne	7/18/2011	14	$8835	$3,804,200	5	$117,808	0	0
South Burlington	7/18/2011	16	$7,625	$4,458,000	4	$8,188	0	0
Underhill	7/18/2011	13	$13,337	$3,782,500	10	$77,287	1	0
Westford	7/18/2011	1	$241	$42,000	0	0	0	0
Williston	8/4/2014	11	$6,167	$2,955,000	4	$23,428	0	0
Winooski	7/18/2011	6	$33,671	$2,225,000	1	$16,236	0	0
Totals		**281**	**$294,717**	**$78,815,300**	**204**	**$2,618,614**	**15**	

A relatively low percentage of properties located within the SFHA have NFIP insurance policies, and the number has declined slightly since the 2017 plan update. The most likely reason for this is that most properties were constructed before floodplain zones were created and properties no long have mortgages that require flood insurance. In the case of structures located in the SFHA of the Lake Champlain shoreline, many were originally constructed as summer vacation homes, known locally as “camps”, and have substantial stone, concrete or metal armoring to protect them from damage. As with the analysis of potential structural losses, data is not available to determine how many of these homes are elevated above the Base Flood Elevation or have other flood protection measures.

4.3.2 RISK ASSESSMENT

[87] National Flood Insurance Program, Community Status Report, May 2022, VEMA Repetitive Loss Properties data.

This section quantifies the risk of the Planning Area to floods. Several factors contribute to the relative vulnerabilities of certain areas in the floodplain. Development, or the presence of people and property in the hazard-specific areas, is a critical factor in determining risk and vulnerability to flooding. Additional factors range from specific characteristics of the floodplain to characteristics of the structures located within the floodplain.

The following is a brief discussion of some of these factors and how they may relate to the Chittenden County planning area.

- Flood depth: The greater the depth of flooding, the higher the potential for significant damages.
- Flood duration: The longer duration of time that floodwaters are in contact with building components, such as structural members, interior finishes, and mechanical equipment, the greater the potential for damage.
- Velocity: Flowing water exerts forces on the structural members of a building, increasing the likelihood of significant damage.
- Elevation: The lowest possible point where floodwaters may enter a structure is the most significant factor contributing to its vulnerability to damage due to flooding.
- Construction Type: Certain types of construction are more resistant to the effects of floodwaters than others. Typically, masonry buildings, constructed of brick or concrete blocks, are the most resistant to damages simply because masonry materials can be in contact with limited depths of flooding without sustaining significant damage. Wood frame structures are more susceptible to damage because the construction materials used are easily damaged when inundated with water.

Methodology – Risk and Vulnerability

GIS was used to determine the possible impacts of flooding within the municipalities and how the risk varies across the Planning Area by jurisdiction. The methodology determined improved parcel counts and values at risk to the 100-year and 500-year annual chance flood events and produced loss estimates. The methodology should be considered “reasonable”; however, uncertainties are inherent in loss estimation methodology, and losses will vary depending on the magnitude of the flood event.

Although Chittenden County does not have unincorporated land to analyze in relation to floodplains, the data for all municipalities is added together to produce countywide totals.

Community Assets at Risk

Flooding only impacts a community to the degree that it affects the lives of its citizens and the community functions overall. Therefore, the most vulnerable areas of a community will be those most affected by floodwaters in terms of potential loss of life, damage to homes and businesses, and disruption of community services and utilities. For example, an area with a highly developed floodplain is significantly more vulnerable to the impacts of flooding than a rural or undeveloped floodplain where potential floodwaters would have little impact on the community.

People

Floods are responsible for more deaths in the U.S. each year than any other hazard. Many fatalities are vehicle-related, but some occur when individuals attempt to walk through areas of flowing water. Flood waters of as little as six inches have enough power to knock a human off their feet, and as little as 12 inches will move cars off roadways. In addition, debris such as boulders, trees, or even houses, may be caught up in the moving water causing threat to life.

A general estimate of the total population in the SFHA can be made by using the estimated total number of residential structures in the SFHA and multiplying by the average household size for the county as a whole (2.37 persons per household). The countywide persons per household figure was used based census data limitations for smaller municipalities.

Based on the data analysis, Richmond (280), Milton (114), and Charlotte (83) have the highest number population residing in the SFHAs, while Essex (9), Essex Junction, Westford (2), Shelburne (5), each show a population of less than 10 persons, respectively. Winooski and South Burlington each show zero persons residing in the SFHA.

Table 4.3.10: Population Residing in 100-Year Floodplain, by Jurisdiction[88]

Municipality	Total Population	Total Residential Structures in Special Flood Hazard Areas	Total Non-Residential Structures in Special Flood Hazard Areas	Total Structures in Special Flood Hazard Areas	Total Population in Special Flood Hazard Areas
BOLTON	1,301	24	8	32	57
BURLINGTON	44,743	23	10	33	55
CHARLOTTE	3,912	35	0	35	83
ESSEX JUNCTION VILLAGE	10,590	3	7	10	7
ESSEX TOWN	22,094	4	2	6	9
HINESBURG	4,698	28	5	33	66
HUNTINGTON	1,934	16	1	17	38
JERICHO	5104	9	5	14	21
MILTON	10,723	48	8	56	114
RICHMOND	4167	118	14	132	280
SHELBURNE	7717	2	3	5	5
SOUTH BURLINGTON	20,292	0	2	2	0

[88] CCRPC Data Base

Municipality	Total Population	Total Residential Structures in Special Flood Hazard Areas	Total Non-Residential Structures in Special Flood Hazard Areas	Total Structures in Special Flood Hazard Areas	Total Population in Special Flood Hazard Areas
UNDERHILL	3129	17	1	18	40
WESTFORD	2062	1	0	1	2
WILLISTON	10,103	10	5	15	24
WINOOSKI	7997	0	3	3	0
Total		**338**	**74**	**412**	**801**

The severity of a flood on a community can be magnified to the degree floodwaters affect vulnerable populations. Those that may require special assistance during a flood event may not be able to protect themselves prior to an event or may not be able to understand potential risks. These can include non-English speaking populations, elderly populations, those without transportation resources, or those in a lower socioeconomic group. Tourists and visitors to the area also have increased risk, as they are less familiar with the geography of the area and the typical means of warning residents regarding dangerous conditions.

Built Environment

Some of the persistent flood-risk issues in the planning area are related to the historical development of the built environment, in that early communities were typically built on waterways for transportation or water sources and these areas remain built-out in many communities today. In addition, structures and redevelopment that took place prior to current land use ordinances and building codes, along with a changing climate have increased flood risk.

Analysis of Chittenden County parcel data indicates a total of 412 structures in the Special Flood Hazard Areas, with 338 residential structures and 74 non-residential structures (commercial/industry/others). A general estimate of the total number of persons living within FEMA flood zones can be made by using the 2020 U.S. Census determination for the countywide number of persons per household (2.37) and multiplying by the number of parcels in flood zones. This estimate represents a total of 801 people living within the Special Flood Hazard Areas. Additional details related to the level of population at risk are provided in the Jurisdiction Annexes.

Table 4.3.11: Summary of Potential Flood-Related Exposure/Loss to 1 Percent Annual Chance Flood Zone by Property Type, by Jurisdiction[89]

[89] Jurisdictional data for Tables 4.3.10 and 4.3.11 is provided only for the 18 participating and adopting jurisdictions. County totals include 19 municipalities.

Municipality	Residential Structures	Non-Residential Structures	Medium Value of Structures[90]		CLA Ratio	Estimated Potential Losses in SFHAs	
			Residential	Non-Residential		Residential ($)	Non-Residential ($)
BOLTON	24	8	$294,800	215,300	1.0257	7,257,033	1,766,666
BURLINGTON	23	10	$319,500	400,000	0.8751	6,430,672	3,500,400
CHARLOTTE	35	0	$537,300	1,308,650	1.0507	19,758,939	0
ESSEX JUNCTION VILLAGE	3	7	$300,000	1,225,000	1.0052	904,680	8,619,590
ESSEX TOWN	4	2	$300,101			1,206,646	
HINESBURG	28	5	$253,000	112,800	0.9204	6,520,114	519,106
HUNTINGTON	16	1	$308,750		1.0264	5,070,416	
JERICHO	9	5	$568,000	3,094,900	0.9874	5,047,589	15,279,521
MILTON	48	8	$270,925	51,946,800	1.0532	13,696,234	437,682,958
RICHMOND	118	14	$552,200	155,600	0.9925	64,670,903	2,162,062
SHELBURNE	2	3	$520,000	224,600	0.9854	1,024,816	663,963
SOUTH BURLINGTON	0	2	$305,444	5,602,250	0.9898	0	11,090,214
UNDERHILL	17	1	$293,600	132,900	1.0181	5,081,541	135,305
WESTFORD	1	0	$399,732		1.0157	406,008	0
WILLISTON	10	5	$494,900	234,200	0.9382	4,643,152	1,098,632
WINOOSKI	0	3	$374,695	4,019,200	0.9834	0	11,857,444
County Total	338	74				141,718,743	$494,375,861

A general estimate of the potential flood-related exposure/loss to structures located in the SFHA can be made by using the estimated medium home value in each jurisdiction and multiplying the number of structures by type (residential/non-residential) times the cost-of-living ratio. Based on the flood analysis, Richmond ($64,670,903), Charlotte ($19,758,939) and Milton ($13,696,234) have the highest total residential values exposed in the SFHAs. Milton (437,682,958) and Jericho ($15,279,521) have the highest total non-residential values exposed in the SFHAs.

Community Lifelines/Critical Facilities

The impacts of floodwaters on Community Lifelines in Chittenden County, such as police and fire stations, hospitals, and water or wastewater treatment facilities can greatly increase the overall effects of a flood event on a community. Although relatively few of these facilities within the municipalities are in areas with a high risk of flooding, there are situations in which critical infrastructure might be at risk.

- Debris picked up by moving flood waters presents an additional threat to property and infrastructure as it is carried downstream, blocking culverts or bridges, and further exacerbating property damage.
- As the climate continues to warm and more excessive rainfall events are experienced, stormwater capacity issues might contribute to flooding in areas that have not previously

[90] **www.homes**

been impacted. Mitigation planning should continue to identify where water will go when capacity is exceeded which includes maintenance of natural drainage channels and over-building stormwater systems to account for future capacity needs.

Most of the municipalities' road mileage is paved (67.26 percent) and very little (5.16 percent) is soil/graded or unimproved, making it less susceptible to flood-related erosion of roadways.

Natural Environment

A watershed is a widespread, uphill area that drains to a body of water. Water collected within a watershed sometimes flows a significant distance to its point of drainage. Natural areas within the floodplain often benefit from periodic flooding as a naturally recurring phenomenon. These natural areas often reduce flood impacts by allowing absorption and infiltration of floodwaters.

Areas with natural forests or little development, depending on multiple factors such as the amount of rainfall or snow melt, capacity of the drainage system, and obstructions in the drainage channel, are usually sufficient to carry off rainfall from the watershed to the body of water. However, in more developed areas or with excessive volumes of water, stormwater systems are sometimes inadequate to carry off the amount of water within the watershed. When this occurs, it creates an impaired stormwater system that could result in flash floods. The faster-flowing water is more likely to overwhelm storm drains, blow out culverts and in some places overwhelm the sewage treatment plant.

Urban areas are especially susceptible to faster-moving water due to having more impervious surface that does not allow water to soak into the soil where rain falls. In addition, sandy soils can soak up more water as opposed to clay soils, and steep slopes tend to move water faster. Natural ground cover allows more filtration of rainwater into the soil and decreases the speed and volume of flowing water. Multiple municipalities have stormwater- impaired watersheds in Chittenden County, specifically within Burlington, Essex, Essex Junction, Shelburne, South Burlington, and Williston.

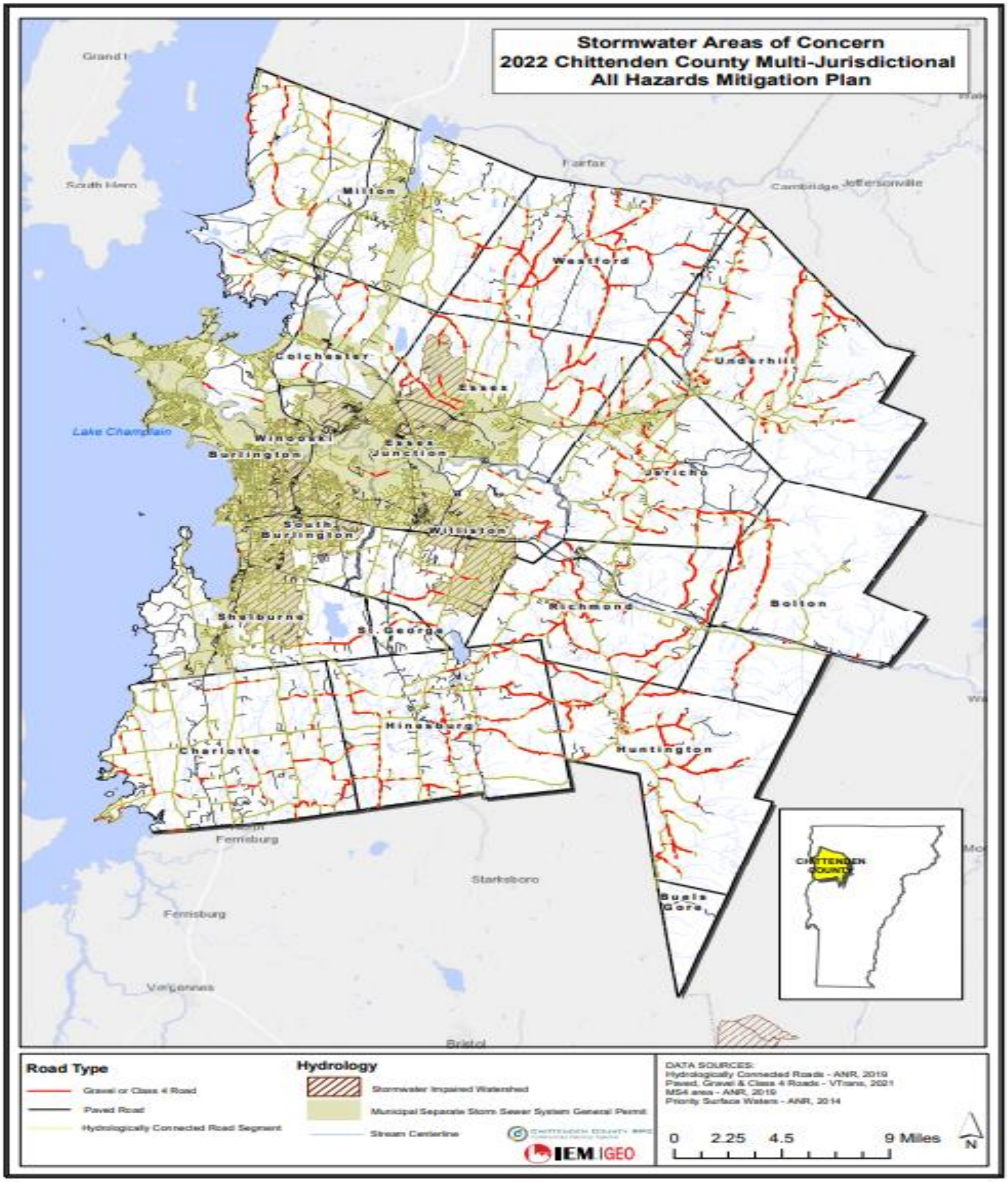


Figure 4.3.7: Stormwater Management Areas of Concern[91]

[91] Vermont Agency of Natural Resources

Economy

The impacts of flooding can have both short-and long-term impacts on a community's economic vitality. Initial flooding may damage commercial buildings and impair access, resulting in direct economic loss. If flooding doesn't quickly recede or property repairs are delayed, indirect economic losses may result due to loss of business also impacting employee wages and jobs.

The 2018 *VT SHMP* identifies two towns within Chittenden County that have economic centers with infrastructure and commercial buildings at risk.[92] Based on the Vermont Economic Risk Index (VERI), Essex has a high ranking related to infrastructure vulnerability based on a critical employer. Richmond also has a high ranking in this category but is noted to have conducted several structural elevation projects which reduce the level of risk.

Cultural and Historical Resources at Risk

Chittenden County and its 19 municipalities have significant cultural, historical, and natural resources located throughout the county. Risk analysis of these resources was minimally conducted due to data limitations; however, the FEMA FIRM datasets were overlaid on a historical resource data layer to identify the number and locations of historically significant structures at risk.

---

[92] Vermont Economic Risk Index (VERI). Retrieved at: http://accd.vermont.gov/community-development/flood/veri

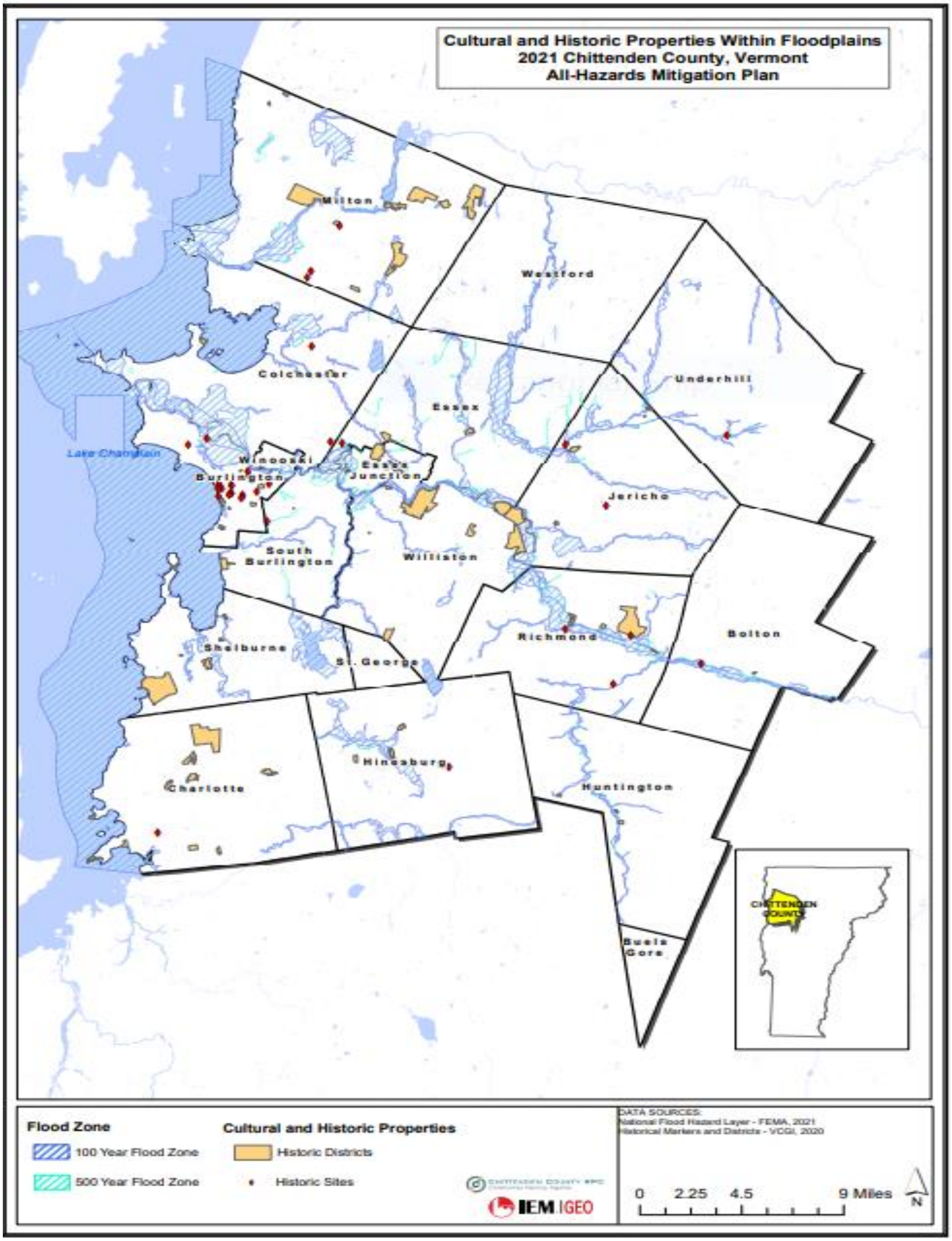


Figure 4.3.8: Location of Historic Properties within the 100- and 500-Year Floodplain[93]

[93] Ibid.

Hazard Risk Ranking

Each jurisdiction in the Planning Area conducted a risk analysis to consider impacts, consequences (including magnitude/severity), and probability of future occurrences to determine the Overall Risk Rating for flood.

Table 4.3.12: Flood Hazard Risk Rating Summary, All Municipalities

JURISDICTION	Sum - Impact/ Consequence Score	Probability	Total Risk Rating *(Impact/ Consequences x Probability)*	Hazard Ranking
Bolton	11	5	55	High
Buels Gore	2	3	6	Low
Burlington	2	3	6	Low
Charlotte	5	4	20	Medium
Colchester				
Essex	5	4	20	Medium
Essex Junction	5	4	20	Medium
Hinesburg	6	2	12	Low
Huntington	8	4	32	Medium
Jericho	9	4	36	Medium
Milton	7	4	28	Medium
Richmond	9	5	45	High
Shelburne	5	4	20	Medium
South Burlington	4	4	16	Low
St. George	11	4	44	High
Underhill	9	4	36	Medium
Westford	9	4	36	Medium
Williston	4	5	20	Medium
Winooski	3	4	12	Low
AVERAGE SCORES	6.3	3.9	25.5	Medium

The compilation of jurisdiction risk scores, along with consideration of the hazard profile and potential impacts and consequences, indicates that **flood** is a **high-risk** hazard for three municipalities, and a **medium-risk** hazard for twelve municipalities within the Planning Area. Consequently, a vulnerability assessment is appropriate to identify the level of exposure to the municipalities within the Planning Area.

4.3.3 VULNERABILITY ANALYSIS

Chittenden County's exposure to flood has been analyzed using two methods, historical and scenario.

Historical Analysis

Total values of property and crop damage were determined by past events documented in the NCEI, Storm Events Database for flood, flash flood, and lakeshore flood for the period of 1950 to June 30, 2021, and then annualized to determine a total exposure in dollars.

The NCEI documents a total of 75 flood events within Chittenden County between 1950 and 2021. Events range widely in terms of location, magnitude, and impact. The most frequent flooding events are localized and result from heavy rains in a short period of time over urbanized areas that are not able to sufficiently handle stormwater runoff. Because these events typically do not threaten lives or property and have not resulted in emergency or disaster declarations, detailed historical data of this type of event is not readily available. Flood events occurring between January 1, 1950, and June 30, 2021 as recorded by NCEI, caused an estimated $22,693,000 in total property damage and $2,050,000 in total crop damage, or total damages of $24,743,000.

Table 4.3.13: Annualized Flood-Related Costs in Chittenden County, 1950 to June 2021[94]

Flood Type	Number of Events	Total Property Damage	Annualized Property Damage	Crop Damage	Annualized Crop Damage
Flood	**39**	**$4,238,000**	**$60,113**	**$1,050,000**	**$14,894**
Flash Flood	**31**	**$12,935,000**	**$183,475**	**$1,000,000**	**$14,184**
Lakeshore Flood	**5**	**$5,520,000**	**$78,298**	**0**	**0**
TOTAL	**75**	**$22,693,000**	**$321,886**	**$2,050,000**	**$29,078**

Scenario Analysis

Hazus was used to model a 100-year flood scenario. Hazus is a multi-hazard loss estimation modeling tool developed by FEMA and the National Institute of Building Sciences to provide both a methodology and software application for use in developing multi-hazard losses on a regional scale. Loss estimates are used primarily by local, State, and regional officials to plan and foster efforts to reduce risk from multi-hazards, and to help communities better develop their emergency response and recovery programs.

For the 2022 *MJAHMP* update, a county-level Hazus flood analysis was completed using a 100-year scenario, or a scenario of a flood extent determined as an event that includes a 1 percent annual chance of flooding in any given year. This section highlights points from the Hazus Flood module summary report. Full reports on Hazus data generated for flood are included in Appendix D.

[94] NCEI, Storm Events Database (Event Types: Flash Flood, Flood, Lakeshore Flood). Damage costs presented in year of occurrence values, as reported by the NCEI for January 1, 1950 to June 30, 2021.

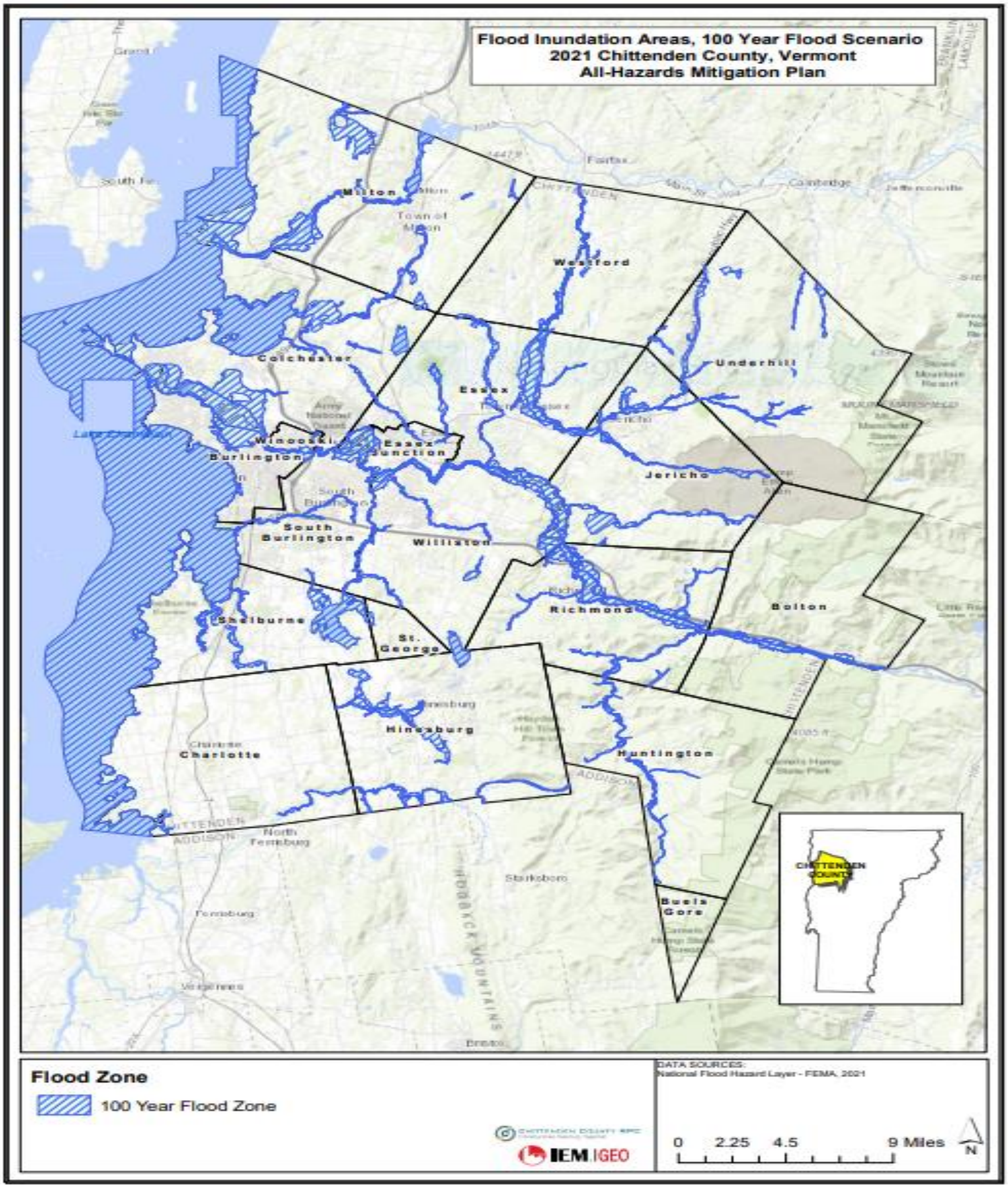


Figure 4.3.9: Flood Inundation Areas, 100-year Flood Scenario[95]

95 Hazus, 100-Year Flood Scenario Report, August 31, 2021.

A community's vulnerability to the flood hazard is calculated by relating potential flooding depth to the annual chance of inundation for that depth. An analysis of the 100-year return interval event was performed to assess risk to essential facilities.

Depth, duration, and velocity of water in the floodplain are the primary factors contributing to flood losses. Associated hazards that contribute to flood losses include channel erosion and migration, sediment deposition, bridge scouring, and the impact of flood-borne debris. The Hazus flood model allows users to estimate flood losses due to flood velocity to the general building stock. The flood model does not currently estimate losses due to high velocity flash floods. Building stock exposure is discussed in detail in the Hazus building stock sections of

Section 4, Hazard Identification and Risk Assessment Methodology.

The Hazus flood assessment included streams and coastal regions located in the planning area with a drainage area of ten square miles or more. The flood depth grid was developed for the 100-year return period.

The Hazus report for flood includes summaries of physical damage to residential and commercial buildings, schools, essential facilities, and infrastructure; and economic loss including lost jobs, business interruptions, repair, and reconstruction costs. Loss estimation for this Hazus module is based on specific input data: square footage of buildings for specified types or population; and local economic data for use in estimating the economic impact of flood hazards. Data for this analysis was provided at the census block level.

Table 4.3.14: Hazus Direct Economic Loss Categories and Descriptions[96]

Name	Data Input for Hazus Model	Hazus Output
Building	Cost per square feet (sq. ft.) to repair damage by structural type and occupancy for each level of damage	Cost of building repair or replacement of damaged and destroyed buildings
Contents	Replacement value by occupancy	Cost of damage to building contents
Inventory	Annual gross sales in dollar per sq. ft.	Loss of building inventory as contents related to business activities
Relocation	Rental costs per month per sq. ft. by occupancy	Relocation expenses (for businesses and institutions)
Income	Income in dollar per sq. ft. per month by occupancy	Capita-related incomes losses as a measure of the loss of productivity, services, or sales
Rental	Rental costs per month per sq. ft. by occupancy	Loss of rental income to building owners
Wage	Wages in dollar per sq. ft. per month by occupancy	Employee wage loss as described in income loss

[96] Hazus

The Hazus flood analysis indicates that Chittenden County, in a 100-year flood scenario, has an exposure of $1,616,891,000 in building damages due to flood events[97].

For the flood scenario model, the built-in default inventory of assets (known as Level 1 analysis) included in the standard Comprehensive Data Management System (CDMS) was used, with no inventory adjustments made to account for locally reported critical assets. As such, discrepancies may appear between self-reported critical asset data, and Hazus-generated data included in this section.

Essential Facilities at Risk

There are 25 critical facilities in the Planning Area located in the 0.1 percent annual chance and 0.2 percent annual chance flood zones. Specific details related to the municipalities' critical facilities located in flood zones are further described in the Jurisdiction Annexes.

Table 4.3.15: Critical Facilities Exposure to FEMA Floodplains, by Jurisdiction

JURISDICTION	Total Facilities	In 100-Year Floodplain	In 500-Year Floodplain
Bolton	4	1	3
Buels Gore	0	0	0
Burlington	1	1	0
Charlotte	0	0	0
Essex	2	2	0
Essex Junction	3	3	0
Hinesburg	1	1	0
Huntington	3	0	3
Jericho	1	1	0
Milton	1	0	1
Richmond	4	4	0
Shelburne	5	5	0
South Burlington	0	0	0
St. George	0	0	0
Underhill	3	3	0
Westford	1	1	0
Williston			
Winooski	1	1	0
Total	25	18	7

Individual municipality maps illustrating this data are included in the jurisdiction annexes.

[97] Hazus, 100-Year Flood Report, August 31, 2021.

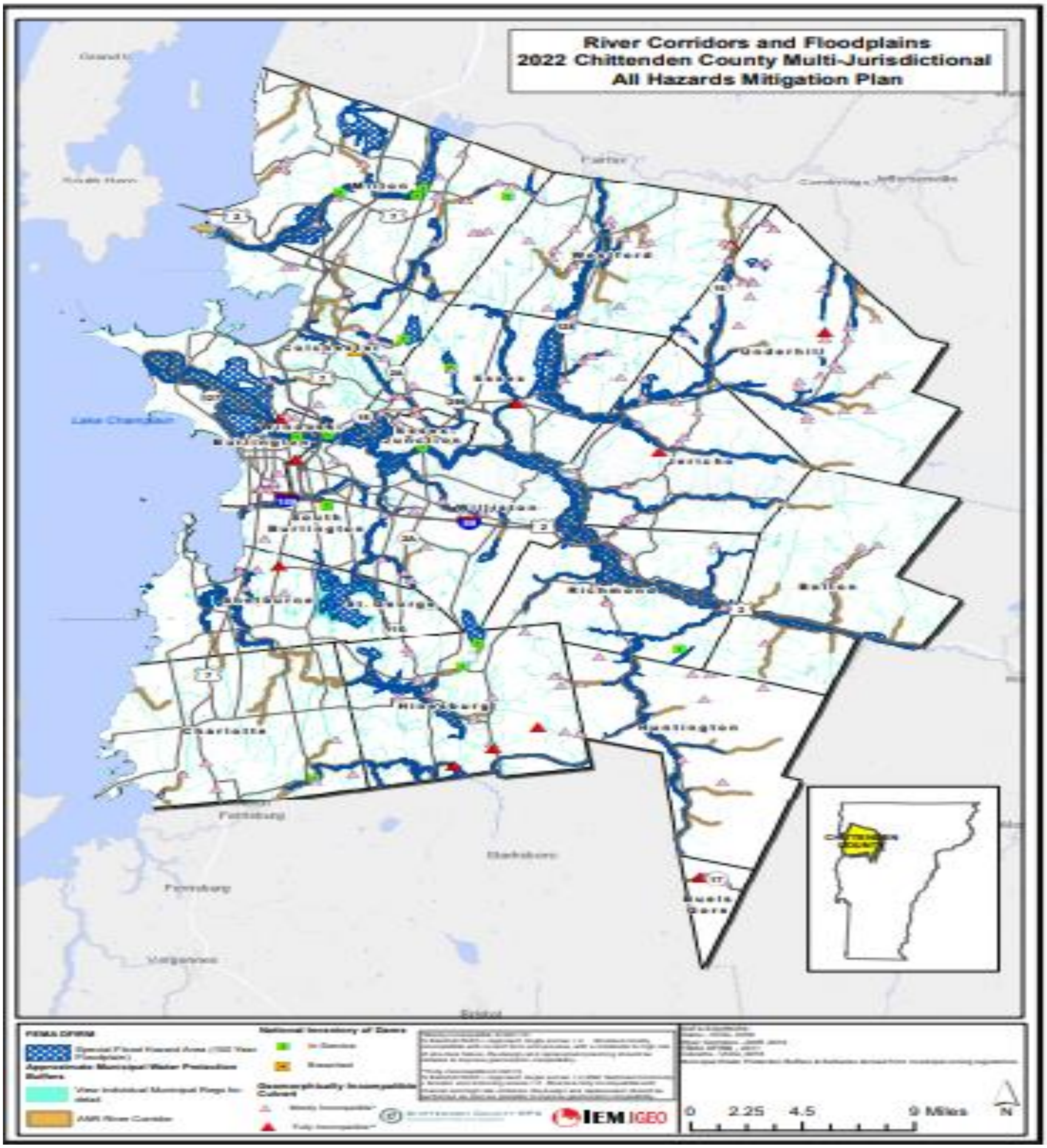


Figure 4.3.10: Critical Facilities in Relation to River Corridors and FEMA Flood Zones[98]

[98] FEMA Digital Flood Insurance Rate Maps; Dams - Vermont Department of Environmental Conservation; River Corridors - Vermont Agency of Natural Resources; Culverts – Vermont Conservation Innovation Grants; Municipal Water Protection Buffers and Setbacks - Municipal Zoning Regulations; Critical Facilities – Chittenden County Regional Planning Commission.

The vulnerability of the county's building stock was assessed using GIS analysis to identify an asset's location within the extent of known hazard areas that can be spatially defined. Determinations were made by using the most recent available Hazus data for critical facility locations and delineable hazard areas; however, current data was only available for utility systems and transportation systems. The actual level of risk for each facility should be determined by additional on-site assessment.

Table 4.3.16: Dollar Exposure (in thousands of dollars) of Critical Facilities Potentially At-Risk to Flood[99]

Jurisdiction	Fire Stations	Hospitals	Police Stations	Schools	Utility Systems	Transportation Systems	Total
Chittenden County	Not available	Not available	Not available	Not available	$665,741	$3,506,494	$4,172,235

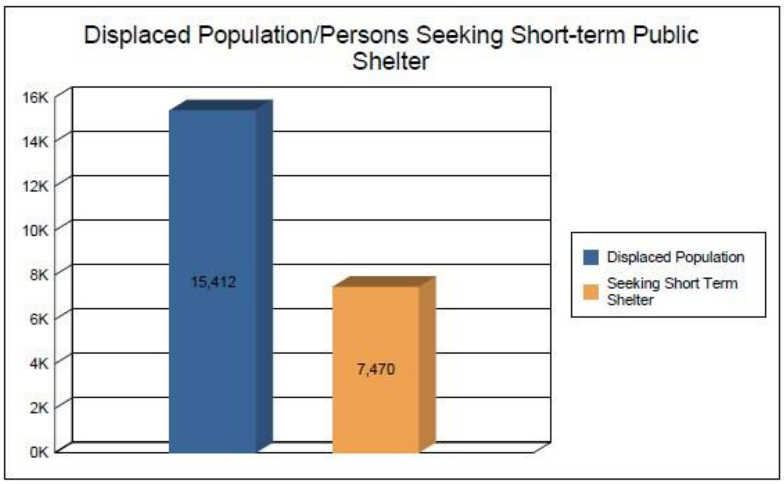


Figure 4.3.11: Displaced Population Compared to Persons Seeking Short-term Public Shelter[100]

Chittenden County properties most vulnerable to flooding are in SFHAs identified by FEMA, which were produced after Flood Insurance Studies (FIS) for each area were completed. Digital Flood Insurance Rate Maps (FIRMs) are available for all municipalities participating in the NFIP.

Built Environment

[99] Hazus Flood Reports: October 21, 2021 - Fire Station Facilities Damage and Functionality; Care Facilities (Hospital) Damage and Functionality; Police Station Facilities Damage and Functionality; School Damage and Functionality; Emergency Operation Center Damage and Functionality
[100] Hazus

Based on the Hazus flood reports, there are a number of buildings potentially damaged in a 100-year flood scenario, based on the range of damage by percentage. Data indicates the higher vulnerability of wood structures in this flood scenario.

Table 4.3.17: Building Damage Count by General Building Type (by percentage) for 100-Year Flood, Chittenden County[101]

Building Material	Average Damage (%) Within Each Damage Range							
	<1	1-10	11-20	21-30	31-40	41-50	Substantial	TOTAL
Steel	0	2	0	0	0	0	0	2
Masonry	0	1	0	0	0	0	0	1
Wood	37	153	126	39	19	7	5	386
Concrete	0	0	0	0	0	0	0	0
Manufactured Housing	12	0	0	0	0	0	2	14
TOTAL	49	156	126	39	19	7	7	403

Hazus identifies building damage by type of construction and percentage of damage for a 100-year flood scenario. The data indicates the relative strength of concrete structures and vulnerability of wood structures in withstanding this type of hazard scenario.

Table 4.3.18: Building Damage by Building Type (in thousands of square feet) for 100-Year Flood, Chittenden County[102]

Building Material	Average Damage (%) Within Each Damage Range (in thousands of square feet)						
	<1	1-10	11-20	21-30	31-40	41-50	Substantial
Steel	28.0	111.0	102.0	25.0	12.0	8.0	6.0
Masonry	34.0	81.0	66.0	14.0	7.0	5.0	1.0
Wood	151.0	418.0	371.0	151.0	73.0	36.0	37.0
Concrete	5.0	20.0	14.0	2.0	0.0	0.0	0.0
Manufactured Housing	23.0	0.0	0.0	1.0	0.0	0.0	3.0
TOTAL	241.0	30.0	553.0	193.0	92.0	49.0	47.0

The potential exposure of buildings, by type, based on a 100-year flood scenario indicates that buildings constructed of wood have the highest level of exposure, followed by masonry construction.

Table 4.3.19: Building Stock Exposure (in thousands of dollars) by Building Type for 100-Year Flood, Chittenden County[103]

[101] Hazus Report Building Damage by Building Type, October 21, 2021.
[102] Hazus Report Building Damage by Building Type, October 21, 2021.
[103] Hazus Report Building Stock Exposure by Building Type, October 21, 2021.

Wood	Steel	Concrete	Masonry	Manufactured Housing	TOTAL
13.136.876	2,726,557	1,246,387	3,058,947	167,287	20,336,054

Examining the potential building damage count by general occupancy, indicates the high number of residential structures at risk in a 100-year flood scenario.

Table 4.3.20: Building Damage Count by General Occupancy (by number) for 100-Year Flood, Chittenden County[104]

Building Material	Count of Buildings (#) by Range of Damage (%)							
	<1	1-10	11-20	21-30	31-40	41-50	Substantial	TOTAL
Education	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0
Residential	49	157	127	39	19	7	7	405
Industrial	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0
Government	0	2	0	0	0	0	0	2
TOTAL	49	159	127	39	19	7	7	407

The potential building stock exposure by general occupancy (in thousands of dollars) based on a 100-year flood scenario, again demonstrates the vulnerability of residential structures to the impacts of this hazard.

Table 4.3.21: Building Stock Exposure by General Occupancy (in thousands of dollars) for 100-Year Flood, Chittenden County[105]

Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	TOTAL
$14,866,050	$3,687,915	$865,812	$65,133	$242,454	$200,006	$408,670	$20,336,040

Natural Environment

Flood and flash flood events typically generate large amounts of debris carried by fast-flowing water to areas within and outside of identified floodplains and river corridors. The 100-year flood scenario calculated by Hazus provides an estimate of potential tonnage of debris from such an event, which could exceed 5,000 tons.

Table 4.3.22: Debris Summary Report (in tons), for 100-year Flood, Chittenden County

Finishes	Structures	Foundations	TOTAL
2,303	1,697	1,297	5,267

104 Hazus Report Building Damage County by General Occupancy, October 21, 2021.
105 Hazus Report Building Stock Exposure by General Occupancy, October 21, 2021.

Direct Economic Losses

The Hazus model develops building capita stock and income losses annualized for a single100-year event broken down into the respective subcategories. Capita stock losses include losses for building, contents, and inventory; income losses include relocation, capita-related, wages, and rental income losses.

Table 4.3.23 Direct Economic Losses for Buildings and Building Economic Losses (in thousands of dollars), for 100-year Flood, Chittenden County[106]

Capita Stock Losses				Income Losses				Total Loss
Building Loss	Contents Loss	Inventory Loss	Building Loss Ratio %	Relocation Loss	Capita Related Loss	Wages Losses	Rental Income Loss	
$56,897	$64,387	$1,887	1.8	$19,089	$24,849	$65,470	$7,752	$240,331

National Risk Index (NRI)

Additional data for measuring risk is used as a comparative tool for this Plan update. The NRI assessment includes an Expected Annual Loss (EAL) calculation which quantifies loss for relevant consequence types (buildings, people and agriculture) for multiple hazards including flood. The EAL is calculated using a multiplicative equation that includes exposure, annualized frequency, and historic loss ratio risk factors.[107]

Table 4.3.24: Expected Annual Loss Values for Riverine Flooding, Chittenden County[108]

Building Value	Population Equivalence[109]	Population	Agriculture Value	Total Loss
$461,510	$148,103	0.02	$40,447	$649,950

Table 4.3.25: Exposure Values for Riverine Flooding, Chittenden County

Building Value	Population Equivalence[110]	Population	Agriculture Value	Total Value
$481,722,564	$26,571,716,199	3,496,28	$5,197,392	$27,058,636,155

[106] Hazus Report Flood Direct Economic Annualized Losses for Buildings, September 2021
[107] The National Risk Index Community Report for Chittenden County, Vermont, dated May 2, 2022 is included in Appendix D.
[108] Community Report, National Risk Index, dated May 2, 2022. Retrieved at: https://hazards.fema.gov/nri/report/viewer?dataLOD=Counties&dataIDs=C50007
[109] The Population Equivalence in the current report was calculated using a value of statistical life (VSL) approach where each fatality or ten injuries is treated as $7.6 million of economic loss.
[110] The Population Equivalence is calculated

4.3.4 HAZARD SUMMARY

The loss estimates and ranking results for the flood hazard in Chittenden County are principally based on the results of the detailed GIS and Hazus analysis, NCEI Storm Events Database listings, the Hazard Identification and Risk Assessment included in the 2018 *Vermont State Hazard Mitigation Plan*, the National Risk Index, and each jurisdiction's qualitative ranking.

There is no one perfect data source that can be used for this purpose; however, the various tools provide a blended picture of hazard risk and vulnerability for flood that can serve as a guide for identifying appropriate mitigation measures.

Potential Impacts of Climate Change

As the climate continues to change, flooding is likely to be more frequent with smaller floods caused by heavier rains and inadequate drainage capacity in urbanized areas but may not be as costly as the large-scale floods which may occur at much less frequent intervals.

Future Population and Development Trends

All municipalities in Chittenden County, except Buel's Gore, which does not contain any known flood hazard areas, participate in the National Flood Insurance Program (NFIP). Since the 2017 *MJAHMP*, the town of St. George has joined the NFIP. Consequently, many municipalities have building and zoning protections that limit or prevent inappropriate development in identified floodplains. In addition, the state's River Corridor regulations offer additional protections to future development.

Additional information related to specific municipal land use protections is presented in each jurisdiction annex.

Public Input

A Public Hazard Survey made available to the county residents during the planning process indicated that approximately 20 percent of the more than 200 survey respondent households had directly experienced flooding within the previous five years, and most were either very concerned or somewhat concerned about future flooding. In addition, 72 percent expressed a high level of worry about damage to community lifelines such as schools, utilities, hospitals, etc., and 65 percent were very worried about damage to or loss of waterways or other natural resources. On a ranking of the most important community assets, survey responders were most concerned about hospitals and other healthcare facilities.

Opportunities for Mitigation

Flood events range widely in terms of location, magnitude, and impact. Most frequent flooding events are localized and result from heavy rains in a short period of time over urbanized areas that are not able to appropriately handle stormwater runoff. While events of this type do cause damage to private property, public infrastructure, and crops, and can result in federal declarations, many do not rise to this level and are addressed through local resources.

Consequently, mitigation goals and actions should focus on flood-related issues that cause repetitive impacts and losses. Of prime concern to many municipalities is the need for adequate stormwater management plans and practices to protect transportation infrastructure and natural areas.

Factors for Consideration in the Next Planning Cycle

Future monitoring, evaluating, and updating of this plan should consider the following factors related to flood/flash flood as well as other information from the *VT SHMP* updates:

- Have any flood/flash flood events occurred since adoption of this plan?
- Has any new scientific research or methodology changed the ability to predict flood/flash flood events or assess risk and vulnerability?
- Has there been any significant change in the population, built environment, community lifelines, natural environment, or economy that could affect the risk or vulnerability to flood/flash flood?
- Is there any new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to flood/flash flood?

SECTION 4.4 FLUVIAL EROSION

2022 MJAHMP Update
The hazard was reviewed and a new analysis was performed: • Moved fluvial erosion information from the flood section to a separate hazard section to emphasize risks and vulnerabilities. • Reformatted hazard profile to improve flow, clarity, and graphic presentation. • Updated risk assessment and vulnerability analysis. • Updated data sources and imagery, where available. • Reviewed and re-evaluated hazard ranking using methodology described in Section 4.

<table>
<tr><th colspan="5">Fluvial Erosion</th><th>Overall Vulnerability</th></tr>
<tr><td colspan="5">Definition, Key Terms, and Overview</td><td rowspan="6">Medium</td></tr>
<tr><td colspan="5">Erosion: The gradual breakdown and movement or removal of sediment or soil from one location to another due to both physical and chemical processes of water, wind, and general meteorological conditions.
Fluvial Erosion: The detachment of material of a river or stream bed and the sides. Erosion starts when the flow energy of the water exceeds the resistance of the material of the river bed and banks. Flow energy depends on depth of water and gradient, which affects the stream velocity. The point in time when material is set in motion varies for different particles such as soil or rock.
Deposition: Sediment moved through the process of erosion and deposited in another location downstream or at a lower elevation.
Alluvial fans are formed when rushing streams and waterways carry sediment through narrow channels or valleys. As the rushing water reaches the valley below, it slows down and spreads out, depositing sediment in a fan-shaped landform.</td></tr>
<tr><th>Frequency</th><th>Probability</th><th colspan="3">Potential Magnitude</th></tr>
<tr><td rowspan="2">Medium</td><td rowspan="2">Medium</td><td>Injuries/Deaths</td><td>Infrastructure</td><td>Environment</td></tr>
<tr><td>Low</td><td>High</td><td>Medium</td></tr>
</table>

4.4.1 HAZARD PROFILE

Natural, or geologic, erosion has occurred since the Earth’s formation and continues at a slow and uniform rate each year.

There are two general causes of soil erosion: wind and water. Both can cause significant soil loss. Winds blowing across sparsely vegetated or disturbed land can pick up soil particles and transport them to another location. Water flowing over land also transports soil particles to other locations. Wind erosion generally impacts wider, less well-defined areas than water erosion, but water erosion can transport larger particles than wind. Major storms such as hurricanes may cause significant erosion by combining the impacts of high winds and high velocity water flow over large flooded areas.

The main causes of water erosion are stream or overland flow, and wave action. Stream or overland flow erosion is the result of mechanical or chemical removal and transportation of soil particles to a new location. Wave action can result in shoreline erosion on large bodies of water.

Topography of the area, including size, shape, and slope is a key variable in determining water flow velocity which in turn is a primary factor in the magnitude of the hydraulic forces producing erosion. The greater the slope length and gradient, the more potential an area has for erosion.

Climate can also affect the amount of runoff, especially the frequency, intensity, and duration of rainfall and storms. When rainstorms are frequent, intense, or of long duration, erosion risks are high. Seasonal changes in temperature and rainfall amounts define the period of highest erosion risk for the year.

During the mid to late 1960s, the importance of erosion control gained increased public attention. Implementation of erosion control measures consistent with sound agricultural and construction operations was needed to minimize the adverse effects associated with increasing settling out of the soil particles due to water or wind. The increase in government regulatory programs and public concern has resulted in a wide range of erosion control products, techniques, and analytical methodologies in the United States. These measures are addressed in Vermont through local sedimentation and erosion control programs. While local erosion hazard areas are not consistently identified, the areas of greatest concern are typically those areas consisting of steep slopes and fast running stream channels, as well as large construction sites involved in the excavation and disturbance of their natural state.

In naturally flowing streams, erosion occurs on a consistent, but small-scale, basis within the riparian corridor of the county's streams and rivers. This is part of a normal, natural process and as such is necessary for the proper functioning of the ecosystem of these waterways. However, fluvial erosion on a large scale can damage stream banks and undercut infrastructure such as roads, bridges, and culverts as well as agricultural land and structures, causing severe damage.

Most damage recorded as "flood" damage in Vermont is more accurately associated with fluvial erosion rather than inundation. The 2018 *Vermont State Hazard Mitigation Plan (VT SHMP)*, dated March 6, 2017, contains the following discussion of fluvial erosion, which is relevant to Chittenden County:

> *"In Vermont, most flood-related damage is due to fluvial erosion. Erosion occur[s] when the power of the flood (i.e., the depth and slope of the flow) exceeds the natural resistance of the river's bed and banks. Rivers that have been overly straightened or deepened may become highly erosive during floods, especially when the banks lack woody vegetation, or when the coarser river bed sediments have been removed. In areas where rivers are confined due to human activity and development, they have become steeper, straighter, and disconnected from their floodplains. The more trapped*

> *the river is, the greater power it will gain, which eventually results in a greater degree of damage to critical public infrastructure such as roads and stream-crossings, as well as homes, businesses, community buildings and other man-made structures built near rivers. Fluvial erosion is also increased downstream when all the eroded materials (i.e., sediment and debris) come to rest in a lower gradient reach, clog the channel, and cause the river to flow outside its banks. When severe enough, fluvial erosion can also be the cause of Landslides. The land area that a river accesses to meander and overtop its banks to release flood energy without excessive erosion is known as the River Corridor".*[111]

A **River Corridor** is defined in Vermont statute as:

> *"…the land area adjacent to a river that is required to accommodate the dimensions, slope, planform, and buffer of the naturally stable channel and that is necessary for the natural maintenance or natural restoration of a dynamic equilibrium condition, as that term is defined in section 1422 of this title [10 V.S.A §752)], and for minimization of fluvial erosion hazards, as delineated by the Agency of Natural Resources in accordance with river corridor protection procedures*[112]*."*

The 2018 *VT SHMP* notes how the state's landscape has historically contributed to widespread channelization of rivers and streams, leading to increased agricultural land uses and development of transportation infrastructure. Conversely, channelization, combined with floodplain encroachment, has contributed significantly to the "disconnection of as much as 70 percent" of the state's rivers from their floodplains. This process of catastrophic adjustments of the channels is an unsustainable condition that leads to fluvial erosion damage to adjacent or nearby "human investments" when energized by flood events.[113]

In the process of erosion and deposition, soil erodes from the point where water is impacting the bank of a waterway where it turns, and deposits it downstream or in the floodplain if the water overtops the bank.

[111] 2018 Vermont State Hazard Mitigation Plan, March 6, 2017; page 56.
[112] Section 1422, 10 VSA, §752; [112] https://legislature.vermont.gov/statutes/section/10/032/00752
[113] 2018 VT SHMP; page 58.

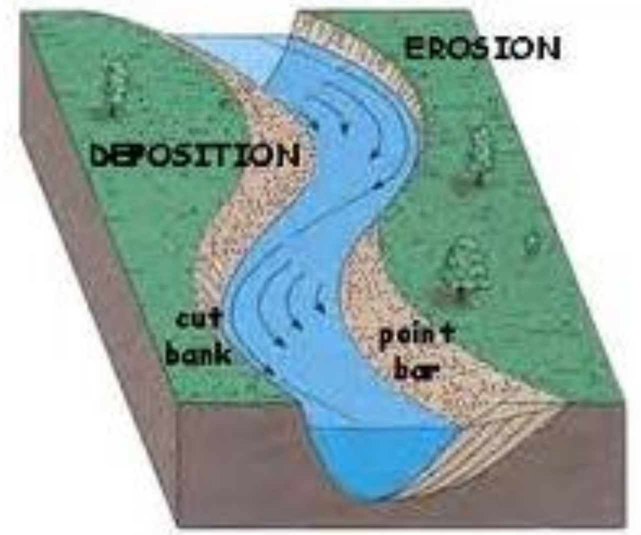


Figure 4.4.1: Process of Erosion and Deposition[114]

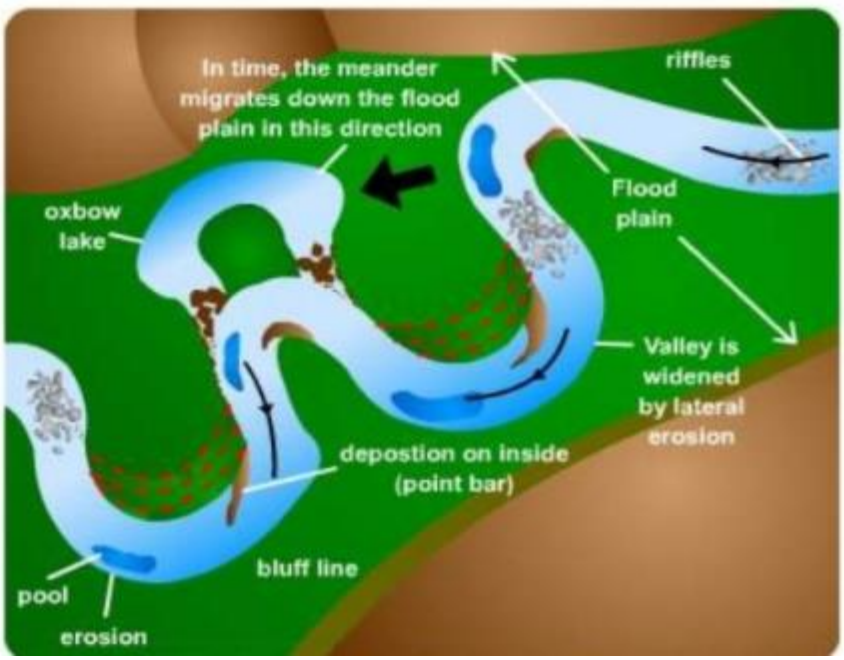


Figure 4.4.2: Combined Effects of Erosion and Deposition[115]

Fluvial erosion occurs in two ways:

- **Vertical erosion**: a river erodes by deepening the bed.
- **Lateral erosion**: a river erodes by broadening its bed. This often results in serious problem such as loss of agricultural lands. Dense vegetation at the river bank may prevent or reduce bank erosion.

[114] Assignmentpoint.com
[115] Slideshare; https://www.slideshare.net/SitiMutiahAliUmar/combined-effects-of-erosion-deposition

Figure 4.4.3: River Corridor Diagram

The *2017 Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan (MJAHMP)* notes that during development and adoption of both the 2005 and 2011 plans, threats from stream erosion were identified as Fluvial Erosion Hazard (FEH) Areas through the analytical lens of a Stream Geomorphic Assessment or SGA. The SGA approach is still used by the Vermont Agency of Natural Resources (ANR) but the Vermont General Assembly adopted two related terms that are now used in managing fluvial erosion hazards.

River Corridors and River Corridor Protection Areas

The ANR identifies and maps River Corridors and River Corridor Protection Areas (RCPA)s. The RCPA is defined as the area within a delineated River Corridor subject to fluvial erosion that may occur as a river establishes and maintains the dimensions, pattern, and profile associated with its dynamic equilibrium condition that would represent a hazard to life, property, and infrastructure placed within the area. The RCPA was previously defined as the meander belt portion of the River Corridor without an additional allowance for a riparian buffer to serve the functions of bank stability and slowing flood water velocities in the near-bank region.

Although the term that previously identified the Fluvial Erosion Hazard (FEH) area was changed to the RCPA, in recent years Vermont DEC has also moved away from the RCPA term and now focuses on **River Corridors**. This land area adjacent to a river is required to accommodate the dimensions, slope, planform, and buffer of the naturally stable channel that is necessary for the natural maintenance or natural restoration of a dynamic equilibrium condition and for minimization of fluvial erosion hazards, as delineated by the Vermont ANR in accordance with river corridor protection procedures. (10 V.S.A. § 1422).The option for municipalities to adopt RCPAs still exists but is no longer encouraged by the ANR. The Agency now recognizes the RCPA as being inconsistent with State policy to achieve stable, least erosive, equilibrium conditions in the state's streams and rivers. The primary objective of River Corridor protection, as defined in Vermont Statute, is to provide enough lateral space for a river to achieve a stable slope (meander geometry) and minimize fluvial erosion hazards. The RCPA is a partial river corridor, as defined, lacking the 50-foot setback provision required to protect the full meander belt of a River Corridor. Thus, ANR does not promote the RCPA via the state model bylaws since it will not maximize hazard mitigation and water quality objectives.

Communities that adopt and regulate the RCPA will not be eligible for the 17.5 percent Emergency Relieve and Assistance Fund (ERAF) cost share since protecting the RCPA does not provide enough lateral space to reduce erosion hazards over time. Towns opting to regulate the RCPA should be aware that support from ANR will be largely unavailable since the agency is dedicating its resources to mapping and protection of the full River Corridor, consistent with state policy. Early Adopter communities that adopted partial River Corridor protection standards or protective flood inundation regulations prior to the ERAF rule going into effect on October 23, 2014 have taken important steps toward minimizing stream erosion, reducing exposure to flood hazards, and ensuring public safety, and will remain eligible for the 17.5 percent ERAF cost share under the current ERAF rule. However, it is anticipated that future amendments to the ERAF Rule will change the cost-share rate and/or the various qualifying activities for these communities to reduce their exposure to flooding.

Table 4.4.1: Fluvial Erosion Hazard Profile Summary

FLUVIAL EROSION **Assessment: Medium Risk Hazard**	**Location:** Area affected: 100- and 500-year floodplains; River Corridor **Extent:** Major erosion impacting agricultural lands and transportation infrastructure (roads, bridges, etc.); some private property impacts **Duration:** Short- to long-term **Probability:** Medium **Seasonal Pattern:** Summer rainfall events; increased duration of annual spring river flooding from snow melt and ice jams **Speed of Onset –** Moderate to Rapid **Warning Time –** Minimal **Repetitive Loss** – N/A	***Potential Cascading Effects*** • Threat to health and safety • Traffic/roadway damage/closures • Resident/visitor and responder safety • Property damage or loss • Disruption of critical services • Long-term environmental damage • Direct and indirect economic loss

Shoreland Protection The State's Shoreland Protection Act, effective July 1, 2014, regulates activities within 250 feet of the mean water level of lakes greater than 10 acres in size. The intent of the Shoreland Protection Act is to allow reasonable development along the shorelands of lakes and ponds while protecting aquatic habitat, water quality, and maintaining the natural stability of shorelines. The Vermont ANR administers the Shoreland Protection Act through the Department of Environmental Conservation's Shoreland Permitting. Shoreland Permitting reviews applications for shoreland permits and ensures that new development or redevelopment within Protected Shoreland Areas is conducted according to the standards set forth in the Shoreland Protection Act.

Location

Areas along waterways, streambeds and lakes throughout the county are susceptible to fluvial erosion. In addition to natural bodies of water, roadside cuts, ditches and culverts may be prone to erosion, especially in areas or steep topography and if no erosion control measures are taken.

The Chittenden County Regional Planning Commission (CCRPC), in association with Vermont ANR and other entities has spent several years conducting geomorphic assessments of waterways in most of the county's municipalities. Areas identified in these assessments as vulnerable or susceptible to erosion are designated by Vermont ANR as River Corridors

The River Corridor (RC) mapped areas susceptible to fluvial erosion are combined with Special Flood Hazard Areas (SFHAs) to illustrate specific locations along numerous small and large waterways throughout the county vulnerable to fluvial erosion. The River Corridor is a modelled area based on empirically derived relations between the drainage area, valley slope, channel width, and meander amplitude, indicating the areas most sensitive or prone to fluvial erosion. In addition, estimated municipal water protection buffers, geomorphically incompatible culverts and dams are susceptible to erosion. As with many structures in the SFHA, many structures located within the RC were also constructed prior to the adoption of zoning laws and likely before the adoption of municipal stream setback regulations identified in those same laws.

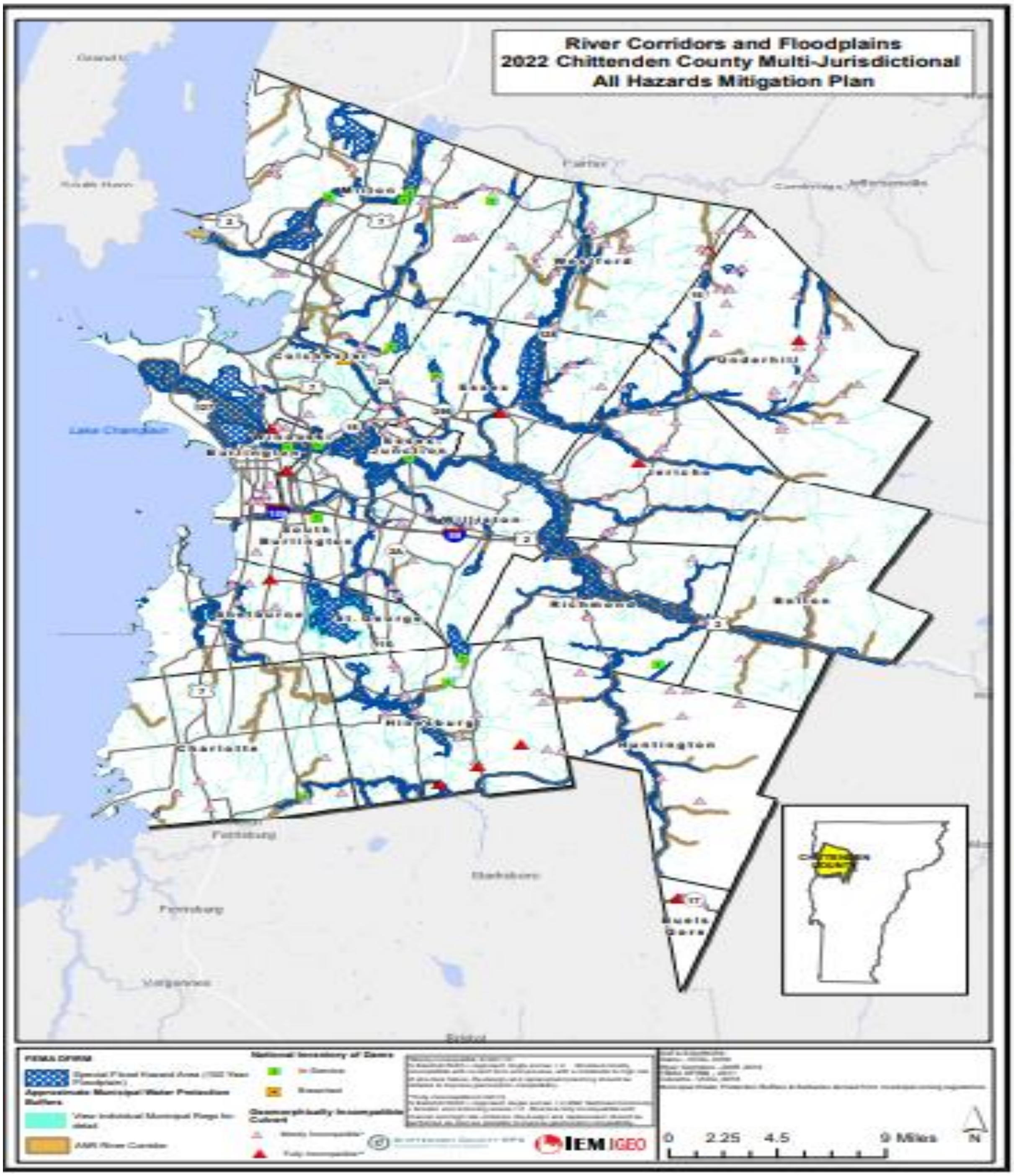


Figure 4.4.4: FEMA Special Flood Hazard Area (SFHA) and River Corridors, with Critical Facilities[116]

[116] FEMA Digital Flood Insurance Rate Maps; Dams - Vermont Department of Environmental Conservation; River Corridors - Vermont Agency of Natural Resources; Culverts – Vermont Conservation Innovation Grants; Municipal Water Protection Buffers and Setbacks - Municipal Zoning Regulations; Critical Facilities – Chittenden County Regional Planning Commission.

The 2018 *VT SHMP* notes that changes in watershed hydrology have been observed as a localized phenomenon either in small, highly urbanized waters, such as **Morehouse Brook in Winooski**, and **Centennial Brook and Bartlett Brook in South Burlington**; or in small, rural sub-watersheds where clear cutting of a large percentage of the watershed land area has recently occurred[117].

Chittenden County has a shoreline along Lake Champlain and its associated embayment, and tributaries, including the Lamoille and Winooski Rivers, that experience erosion. The accretion and erosion of these shorelines are greatly influenced by wind-induced waves, boat wakes, and storm water runoff. Other contributing factors include the physical characteristics of the shoreline (e.g., topography, soil), as well as human activities (e.g., land use, dredging, and shoreline stabilization).

All the municipalities in the County have substantial shoreland regulations in place through the Shoreland Protection Act, which requires review of permit application for new development or redevelopment within Protected Shoreland Areas and ensures that it is conducted according to the standards set forth in the law.

Extent

While Vermont has field-assessed over 2,100 stream miles to establish the extent of erosion and rate of river sensitivity, neither the State of Vermont or the Federal Emergency Management Agency (FEMA) has consistently collected data on impact severity or past occurrences. Bank erosion and the degree of meander migration (over a 20-year span) are documented in the Stream Geomorphic Assessment (SGA) program, but before-and-after monitoring of the number of feet-acres of soil lost in any one event has not been completed to date. Given the growing awareness of this hazard as a distinct cause of flood-related damage, a strong case could be made for the collection of such event data. Despite this lack of data, the All -Hazards Mitigation Plan Update Committee (AHMPUC) recognizes that damages by this hazard have been caused in the past and could be caused in the future and therefore has included it in the 2022 MJAHMP update.

Past Occurrences

There is no known database of historic erosion events in Chittenden County. Erosion events are typically extremely localized in nature and often go unreported unless they cause damage to infrastructure, are reported as flood-related damage, or the resulting topography presents new hazard. areas.

Probability of Future Events

The probability of future fluvial erosion events remains likely in localized areas throughout Chittenden County, especially along steep rivers, and stream channels, and in River Corridor

[117] Source: 2018 Vermont State Hazard Mitigation Plan, March 6, 2017; Flood Insurance Rate Maps (FIRMs), National Flood Insurance Program

Climate change science indicates that with increased storm events, flood-related erosion would also be expected to increase.

Due to the lack of consistent methodology and data related to previous fluvial erosion events, an exact probability or recurrence interval is unable to be determined for this Plan update.

4.4.2 RISK ASSESSMENT

Population

Although there are not typically significant areas of population within land susceptible to fluvial erosion, residents living in sparsely populated areas near steep river and stream valleys could be impacted by this hazard. Of particular concern is residents isolated for either short- or long-term periods due to road or bridge closures caused by fluvial erosion.

Built Environment and Community Lifelines

Incidents of fluvial erosion that cause damage are most likely to affect transportation infrastructure, such as roads, culverts, bridges, and rail lines, and private property where residential construction has encroached in River Corridors

Some water supply sources and distribution systems are also endangered by fluvial erosion because of buried pipes that cross streams. Damage to water supply mains is a potential consequence of fluvial erosion. In Chittenden County. The Jericho-Underhill Water District has tried to address channel stability in the **Browns River** to prevent the loss of water infrastructure to fluvial erosion hazards.

Natural Environment

The *Vermont Agency of Natural Resources, Stream Geomorphic Assessment (SGA), Program Introduction*, undated, notes key assumptions about fluvial geomorphic science that affect risk to the environment:

- Human-related physical change to river channels, flood plains, and watersheds often mimic and/or change the rate of natural physical processes.
- The distribution and condition of stream types, especially those indicative of reach and watershed scale adjustments, influence erosion and flood hazard risk levels and aquatic habitat quantity and quality.

Economy

Older commercial structures and areas built close to waterways prior to the establishment of River Corridors are more susceptible to the impacts of fluvial erosion. This could lead to short-or long-term economic impacts either from direct loss due to property damage or indirect loss due to business closures.

Hazard Risk Ranking

Each jurisdiction in the Planning Area conducted a risk analysis to consider impacts, consequences (including magnitude/severity), and probability of future occurrences to determine the Overall Risk Rating for fluvial erosion.

Table 4.3.9: Fluvial Erosion Hazard Risk Rating Summary, All Municipalities

JURISDICTION	Sum - Impact/ Consequence Score	Probability	Total Risk Rating *(Impact/ Consequences x Probability)*	Hazard Ranking
Bolton	11	5	55	High
Buels Gore	5	4	20	Medium
Burlington	5	4	20	Medium
Charlotte	5	4	20	Medium
Colchester	5	4	20	Medium
Essex	5	4	20	Medium
Essex Junction	5	4	20	Medium
Hinesburg	5	4	20	Medium
Huntington	9	4	36	Medium
Jericho	9	4	36	Medium
Milton	6	4	24	Medium
Richmond	10	5	50	High
Shelburne	6	4	24	Medium
South Burlington	4	5	20	Medium
St. George	3	4	12	Low
Underhill	9	4	36	Medium
Westford	9	4	36	Medium
Williston	3	4	12	Low
Winooski	1	4	4	Low
AVERAGE SCORES	6.3	3.9	25.5	Medium

The compilation of jurisdiction risk scores, along with consideration of the hazard profile and potential impacts and consequences, indicates that **fluvial erosion** is a **high-risk** hazard for two municipalities, and a **medium-risk** hazard for fourteen municipalities within the Planning Area. Consequently, a vulnerability assessment is appropriate to identify the level of exposure to the municipalities within the Planning Area.

4.4.3 VULNERABILITY ANALYSIS

The county's vulnerability to erosion is primarily limited to those immediate areas along rivers, creeks, and streams, and to areas of loose soils with steep slopes. For this reason, vulnerability of the county and its municipalities to erosion is difficult to determine because there are no historical records for previous occurrences of erosion events that clearly separate damage caused by fluvial erosion from flood-related damage. Potential losses related to fluvial erosion are mapped in the River Corridors located along numerous small and large waterways throughout the county. As with structures in the SFHA, many of the structures located within the RC were constructed prior to the adoption of current zoning codes and likely before the adoption of municipal stream setback regulations identified within these codes.

Despite the expectation of low impact to structures, a general statistical analysis of residential and commercial/industrial structures located within RC can be made. It should be noted that the potential loss analysis does not include the RC for small streams, those with drainages less than two square miles, where significant erosion damage to property and infrastructure in the county's narrower valleys has been observed in the past.

Table 4.4.2: Estimated Potential Losses in Special Flood Hazard Areas (SFHAs), by municipality[118]

Municipality		Structures Located in SFHA		Median 2020 Grand List Value of Structures in SFHA			Estimated Potential Loss in SFHA	
	Total Sites	Residential	Commercial/ Industrial/ Other	Residential	Commercial/ Industrial/ Other	CLA Ratio	Residential	Commercial/ Industrial/ Other
Bolton	542	24	12	$155,750	$276,250	0.9607	$3,591,097	$3,184,721
Buels Gore	20	0	0	$0	$0	0.8116	$0	$0
Burlington	12,021	22	23	$165,300	$319,600	0.7765	$2,823,820	$5,707,896
Charlotte	1,923	36	2	$238,050	$1,083,950	0.9766	$8,369,267	$2,117,171
Colchester	6,515	63	17	$199,750	$676,100	0.9147	$11,510,813	$10,513,287
Essex (& Essex Junction)	7,388	7	13	$159,500	$522,100	0.9415	$1,051,185	$6,390,243

118 Chittenden County Regional Planning Commission Analysis. NOTE: This data does not include an analysis of the relative susceptibility to erosion of the individual stream reaches in which a structure is located.

Municipality		Structures Located in SFHA		Median 2020 Grand List Value of Structures in SFHA			Estimated Potential Loss in SFHA	
	Total Sites	Residential	Commercial/ Industrial/ Other	Residential	Commercial/ Industrial/ Other	CLA Ratio	Residential	Commercial/ Industrial/ Other
Hinesburg	1,936	28	5	$266,200	$333,700	0.998	$7,438,693	$1,665,163
Huntington	923	16	6	$204,500	$202,000	0.9736	$3,185,619	$1,180,003
Jericho	2,075	9	5	$300,700	$13,674,200	1.0053	$2,720,643	$68,733,366
Milton	4,385	48	26	$166,800	$232,090	0.9588	$7,676,536	$5,785,725
Richmond	1,794	117	16	$230,550	$16,100	0.9315	$25,126,607	$239,954
St. George	342	0	0	$0	$0	0.9306	$0	$0
Shelburne	3,329	2	4	$2,761,350	$897,050	0.9507	$5,250,431	$3,411,302
So. Burlington	7,107	0	3	$0	$1,586,300	0.9328	$0	$4,439,102
Underhill	1,303	17	1	$220,600	$132,900	0.9819	$3,682,321	$130,495
Westford	877	1	0	$190,200	$0	0.9604	$182,668	$0
Williston	4,486	10	6	$456,815	$718,810	0.949	$4,335,174	$4,092,904
Winooski	1,748	0	3	$0	$2,437,200	0.8851	$0	$6,471,497
County:	58,714	400	142	$5,716,065	$23,108,350		$86,944,875	$124,062,830
Total Structures in Floodplain:			**542**	**Total Estimated Potential Loss**			**$211,007,705**	

In most cases where erosion poses an imminent threat to property, erosion control techniques are typically applied before damages occur. While this provides substantial protection, it is not guaranteed to prevent future structural damage to homes and businesses as riprap or other armoring can fail or be outflanked. In addition, bank armoring can be prohibitively expensive for private homeowners to undertake and there are no programs that provide them with funding or resources for this type of work.

Damage to public infrastructure, such as roads, bridges, and culverts, will be relatively frequent, approximately once every five to ten years. Armoring of banks to stop erosion may prevent damage in some events, but, as with private residences, does not eliminate or guarantee that erosion damage would not occur. In addition, the designation of River Corridors provides regulatory oversight that prohibits or limits development in these areas.

In a declared event, FEMA Public Assistance, and/or the National Resource Conservation Service’s (NRCS) Emergency Watershed Protection Program (EWPP) may have funds available to assist with restoration of private land if the town or community agrees to the grant requiring assistance the individual landowner. Many communities turn down these opportunities and the landowner is left with no feasible alternatives.

Built Environment and Community Lifelines

For the purpose of this Plan update, because fluvial erosion is most frequently linked to flood damage reports, vulnerability of community lifeline infrastructure for fluvial erosion is presented within **Section 4.3, Flooding**. Estimated losses for building stock and critical infrastructure were calculated through the Hazus, Level 1, modeling tool for types of structures and general occupancy. Data related to Community Lifelines, including fire and police stations, hospitals, utilities, and educational facilities, was utilized within the Hazus database to calculate potential losses.

It should be emphasized that the estimated loss analysis calculated by Hazus represents a worst-case scenario where extensive fluvial erosion would occur from a long-duration flood event that impacts even the least sensitive stream reaches. The Vermont DEC River Corridor mapping includes ratings indicating relative vulnerability to fluvial erosion hazards:

> *"…the width of a river corridor is scaled to the size of a stream. Smaller tributaries have narrower corridors associated with them. The width of area corridors also depends upon its sensitivity. For example, a steep, headwater stream with a bed made up mostly of boulders is very stable. (Very Low sensitivity rating), limiting its corridor to the width of the channel. In contrast, a meandering, lowland stream with fine substrate is much more prone to lateral migration and sensitive to disturbance (Very High sensitivity rating). In this case, the corridor, based on the stream meander belt, would be six to eight channel widths wide.*[119]

Based on everyday experience in the county, along with the history of federally declared disasters, the most common and likely losses due to fluvial erosion are damages to transportation infrastructure, primarily roads and culverts. Unlike damages to structures, estimating potential losses/damages to this type of infrastructure is extremely challenging for several reasons. First, there are no standardized replacement costs for culverts and bridges as costs are unique to each location and type of structure. Second, regarding road damages, there is no way to predict, for example, how many linear feet of roadway would be eroded by adjacent streams, or the linear feet washed away by an excess volume of rain flowing down a poorly constructed roadside ditch on an upland road.

Each municipality has at least several culverts that are undersized (in terms of percentage bank full width) relative to their watershed size. The jurisdictional annexes document potentially problematic culverts (in terms of geomorphic incompatibility) that have been identified through field investigations conducted using a Bridge and Culvert Analytical tool as part of the Phase II Stream Geomorphic Assessment. In practice, culverts fail not necessarily from a lack of hydraulic capacity, but from the more random sediment and debris blockages that occur when backwater is created behind an undersized structure. For this reason, routine maintenance of roadside ditches and culverts that includes debris and sediment clearance is critical to ensure water is free flowing through these structures.

[119] 2017 Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan, p. 145

Natural Environment

Of special interest when considering fluvial erosion, is the debris estimation, in tonnage, resulting from a 100-year flood scenario, which is included in **Section4.3, Flooding** and in this section.

Table 4.4.3: Debris Summary Report, for 100-year Flood, Chittenden County[120]

Finishes	Structures	Foundations	TOTAL
2,303	1,697	1,297	**5,267**

Economy

Estimated economic losses related to fluvial erosion can be linked to the Hazus direct economic loss estimates presented in **Section 4.3, Flooding**. Additionally, in many instances people are unable to afford bank stabilization to protect their home and/or there are no resources or funding to provide private homeowners for this type of work.

Cultural and Historical Assets

Many structures were built in the early years of the county's development along the numerous waterways. Sites and structures may have local, state, or federal designation as a landmark; however, this type of designation by itself does not protect a structure from natural or human-caused threats or hazards. If a site or structure has protection through local ordinances due to its historical or cultural significance, there may be limitations to mitigation actions that could reduce or prevent impacts from flooding and fluvial erosion. There is a delicate balance between protecting these assets and carrying out actions for the good of the population or community if they infringe in vulnerable areas. Coordination with local governing bodies and historic preservation boards or advocates is recommended to identify potential structures at risk and develop acceptable options for mitigation.

Potential Impacts of Climate Change

As the climate continues to change, fluvial erosion is likely to be more frequent with smaller floods caused by heavier rains and inadequate infrastructure. but may not be as costly as the large-scale floods which may occur at much less frequent intervals. Stream crossing culverts in upland, mountainous towns are the most vulnerable assets in rural towns while catch basins and stormwater pipes are the most vulnerable assets in the county's suburban and urban communities.

Future Population and Development Trends

All municipalities in Chittenden County, except Buel's Gore, which does not contain any known flood hazard areas, participate in the National Flood Insurance Program (NFIP). Since the 2017

[120] Hazus, Debris Summary Report for Flood., October 2021. The table categories reference the types of construction debris.

MJAHMP, the town of St. George joined the NFIP. Consequently, the municipalities have building and zoning protections that limit or prevent inappropriate development in identified floodplains. In addition, the state's River Corridor regulations offer additional protections to future development if a project is subject to Act 250, the State's land development law. Both the Town of Saint George and the City of South Burlington have adopted the State's model River Corridor Bylaws into their land development regulations.

Public Input Related to Fluvial Erosion

A Public Hazard Survey made available to the public during the planning process indicated that approximately 5 percent of the more than 200 survey respondent households had directly experienced fluvial erosion within the previous five years, but most had only moderate concern about future fluvial erosion events. In addition, approximately 64.5 percent were very worried about damage to or loss of waterways or other natural resources. On a ranking of the most important community assets, survey responders were most concerned about hospitals and other healthcare facilities.

Opportunities for Mitigation

Fluvial erosion events range widely in terms of location, magnitude, and impact. Most events are flood-related, localized, and result from heavy rains in a short period of time over areas. While events of this type do cause damage to property and crops, and can result in federal declarations, most do not rise to this level and are addressed through local resources. Consequently, mitigation goals and actions should focus on identifying areas most vulnerable to flood-related fluvial erosion issues that cause repetitive impacts and losses.

The Vermont ANR's Stream Geomorphic Assessment (SGA) program presents a significant opportunity to identify and evaluate the geomorphic and habitat conditions of streams and watersheds in the planning area. The program is structured in three phases, which upon completion should be able to "tell the story" of the physical nature of a stream, how a sequence of human activities may have combined to initiate a set of responses (or channel adjustments), and the degree to which the end result of those responses can be predicted. The ability to understand large scale channel evolution within a watershed could support development of a river management plan that predicts future channel evolution. Each phase of the SGA includes development of data sets to classify stream types and identify channel movement. The SGA phases include:

- Phase 1: Remote Sensing techniques are used to collect data from various print and online resources and conduct very limited field studies, or "windshield surveys".
- Phase 2: Rapid field assessments to collect field data from measurements and observations at the reach or sub-reach scale.
- Phase 3: Survey-level field assessments to collect detailed quantitative measurements using professional level stream survey and geomorphic skills.

Factors for Consideration in the Next Planning Cycle

Future monitoring, evaluating, and updating of this plan should consider the following factors related to fluvial erosion as well as other information from the *VT SHMP* updates:

- Have any fluvial erosion events occurred since adoption of this plan?
- Has any new scientific research or methodology changed the ability to predict fluvial erosion events or assess risk and vulnerability?
- Has there been any significant change in the population, built environment, community lifelines, natural environment, or economy that could affect the risk or vulnerability to fluvial erosion?
- Is there any new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to fluvial erosion?

SECTION 4.5 HUMAN INFECTIOUS DISEASE

2022 MJAHMP Update

Due to the worldwide "COVID-19" outbreak of a novel coronavirus and the statewide impacts experienced in Vermont, the Chittenden County MJAHMP Planning Committee determined that this hazard should be moved from the list of Societal Hazards, as it was presented in the 2017 MJHMP, and be addressed as a Natural Hazard in this update.

Data related to the COVID-19 outbreak is dynamic; consequently, statistical information within this section related to the outbreak is based on a set timeframe. It will not be updated on any pre-determined schedule, but will be considered during the scheduled monitoring, evaluation, and update process in the next planning cycle, as outlined in **Section 7.**

The hazard was reviewed, and a new analysis was performed, including

- Reformatted hazard profile to improve flow, clarity, and graphic presentation.
- Updated previous occurrences for number of events and losses.
- Updated risk assessment and vulnerability analysis.
- Updated data sources and imagery, where available.
- Reviewed and re-evaluated hazard ranking using methodology described in **Section 4.**

The intent of this section is not to supplant any previous, current, or future planning efforts by state and local public health officials and other agencies, but to provide context with a mitigation focus that supports those efforts. In addition, this section focuses on human infectious disease events of a widespread nature and does not provide health or medical guidance for incidents of individual, sporadic or endemic disease outbreak.

Human Infectious Disease					Overall Vulnerability
Definition, Key Terms, and Overview					Medium
A human infectious disease is one caused by a microorganism, such as a bacterium, virus, or protozoan, that is not normally found in the body and can cause infection. Some, but not all, infectious diseases are contagious, meaning they can spread from person to person. Other infectious diseases can spread from animals or insects to humans, but not from person to person. *(National Institutes of Health)*					
Frequency	**Probability**	**Potential Magnitude**			
		Injuries/Deaths	**Infrastructure**	**Environment**	
Medium	Medium	Medium	Low	Low	

4.5.1 HAZARD PROFILE

Humans are susceptible to various types of infection, most of which can be successfully managed through appropriate and timely medical surveillance, evaluation, and personal care.

Infectious disease outbreaks occur worldwide and are one of the leading global causes of death. The cause, nature, and treatment of each disease differs. Still, all create increased demand on health and medical resources and other government services that could potentially impact citizens' safety and security in every community in the county, state, and nation.

Over twenty well-known diseases – including tuberculosis (TB), malaria, and cholera – have reemerged or broadened geographically since 1973, sometimes in more potent and drug-resistant forms. At least 30 previously unknown disease agents have been identified since 1973, including HIV/AIDS, Ebola, and Nipah virus, for which no cures are currently available. Of the seven (7) prevalent human infectious disease killers worldwide, TB, malaria, and hepatitis continue to surge, with TB and HIV/AIDS likely to account for most deaths from infectious diseases in developing countries in the near future.

In the United States, influenza kills an average of 36,000 people per year. An influenza epidemic on the scale of that which occurred in 1918 could potentially sicken up to 35 percent of the population, including over 200,000 people in Vermont (*Vermont Department of Health, Pandemic Influenza Preparedness and Response Plan (DRAFT)*, 2006). Due to the process of manufacturing vaccines, sufficient supply might not be available in the event of a serious, widespread outbreak of influenza. Chittenden County, like the rest of Vermont, has been affected by several influenza pandemics since 1918. The most recent pandemic was the H1N1 Influenza (or "flu") pandemic of 2009-2010. The H1N1 flu was relatively mild, but sickened many in Chittenden County, and killed three people in Vermont.

The 1918 Spanish Flu infected 28 percent of all Americans. An estimated 675,000 Americans died of influenza, ten times as many as in World War I.

(The Influenza Pandemic of 1918, Stanford University, https://virus.stanford.edu/uda/)

Concerns about avian influenza in 2006 prompted the Vermont Department of Health (VDH) to issue a report, the *Pandemic Preparedness and Response Plan*, outlining the state's response to an influenza epidemic. In Chittenden County and across the state, discussions, workshops, and conferences about pandemic planning took place in 2006 and 2007. Some public education efforts regarding epidemics have been made, most notably in Burlington. Since then, local authorities and private entities have expressed interest in more pandemic planning, particularly in response to the H1N1 pandemic in 2009. This pandemic highlighted concerns for municipal officials about how to maintain continuity of essential services if a large portion of the workforce is incapacitated. There is also concern over how to distribute supplies, enforce quarantines, keep critical personnel from becoming ill, and disseminate information in the case of an epidemic. Local colleges and universities are particularly concerned about the issue, as they would have to decide whether to send students home or keep them in Chittenden County.

The state and local public health agencies routinely carry out Reportable Disease surveillance with their private health and medical partners (see http://healthvermont.gov/prevent/IDN/archive.aspx for additional information). There are multiple diseases that are listed as part of the Vermont Public Health Reportable Diseases list[121]. which also provides additional information on appropriate care if an individual contracts one of these diseases.

Emerging diseases may be transmitted by an infectious agent or microbial toxin. These include but are not limited to the Ebola virus, enterovirus D68, Middle East Respiratory Syndrome (MERS), legionella, and Zika virus.

Transmission of infectious diseases occurs by the following primary modes:

- Airborne (Aerosol/droplet) transmission (inhalation)
- Biological transmission (ingestion)
- Contact transmission (through skin/fluids)

The spread of infectious disease is affected by changes in human behavior, including land-use patterns, increased trade and travel, and inappropriate use of antibiotics.

Types of Outbreaks

Zoonotic

Zoonotic diseases are illnesses that spread from animals to humans and can be passed through direct contact with an infected animal or contact with areas where animals live. Wildlife, livestock and even pets can spread zoonotic diseases to people. For example, baby turtles and chicks can spread *Salmonella*, while bats, racoons and other wild animals can spread rabies to both humans and pets.

Anybody can get a zoonotic disease, but certain groups of people are at higher risk, including children under the age of five, pregnant women, adults over the age of 65, and anyone with a weakened immune system.

The Vermont Department of Health's Zoonotic Disease Program[122] is responsible for monitoring and responding to zoonotic diseases to investigate reported cases and outbreaks, collect and analyze data to detect trends in disease activity, collaborate with other state agencies, and work to educate Vermonters about prevention.

---

[121] Vermont Department of Health. Retrieved at: Infectious Disease Reporting and Data | Vermont Department of Health (healthvermont.gov)

[122] Zoonotic Diseases | Vermont Department of Health (healthvermont.gov)

Vector-Borne

Mosquito season in Vermont begins in the spring but does not typically pose a health risk until the summer months. By July, some mosquitoes may be carrying viruses that cause diseases such as West Nile virus (WNV) and Eastern equine encephalitis (EEE).

The VDH's Vector-borne Disease Program is responsible for tracking and responding to mosquito-borne diseases by investigating cases of disease, collecting, and analyzing data to detect trends in disease activity; collaborating with other state agencies; and educating the public about prevention.

Under its surveillance measures, mosquitoes from around the state are collected and tested for evidence of WNV and EEE. The VDH tracks this information and updates the mosquito surveillance webpage weekly. Prevention of mosquito-borne diseases is limiting exposure to mosquito bites by wearing long-sleeved shirts and long pants when outside, limiting time spent outdoors at dawn and dusk when the mosquitoes are most active, and using an insect repellent that has been proven to be safe and effective against mosquitoes[123].

Diseases spread by ticks continue to be a serious public health concern in Vermont[124]. Tickborne diseases are being reported to the VDH more frequently in the past decade, with Lyme disease being the most common. Other tickborne diseases, such as anaplasmosis and babesiosis, are on the rise as well. Tularemia is a rare disease that can also be transmitted by ticks.

Prevention of tickborne diseases is through limiting exposure to tick bites

Viral Diseases

The following viral disease types have either threatened or been experienced by communities within the United States or Vermont.

Influenza

Influenza, or flu, is a contagious respiratory infection that can be caused by several flu viruses. These viruses generally infect the nose, throat, and lungs and typically occur seasonally. Symptoms include fever, chills, muscle aches, coughing, congestion, headache, and fatigue

[123] Mosquito-borne Diseases | Vermont Department of Health (healthvermont.gov)
[124] https://www.healthvermont.gov/sites/default/files/images/2017/06/BeTickSmart.DarkBlue.png

experienced for a week or more. Most people infected with the flu improve within two weeks; however, some may develop serious complications, such as pneumonia. The U.S. Department of Health and Human Services defines pandemic influenza as a new virulent flu strain, for which most people have no immunity, that spreads easily from person-to-person, causing a global outbreak or pandemic. Because there is little natural immunity, the disease can spread easily from person to person. Various strains of influenza often mutate from animal populations to humans, such as the H1N1 virus or "Swine Flu," which is a respiratory disease of pigs caused by type A influenza virus. Vaccines are typically developed annually, based on the primary type of virus currently impacting large populations. Most outbreaks occur seasonally, beginning in the late fall and winter months, with a lessening of cases by spring.

The influenza virus can infect humans of any age and medical condition; however, depending on the influenza strain and other conditions, the most vulnerable populations are the very young, the elderly, and those with compromised immune systems or underlying health conditions.

There were four pandemic influenza events in the past century: 1918 ("Spanish Flu"), 1957 (H2N2 or "Asian Flu"), 1968 (H3N2 or "Hong Kong flu"), and 2009 (H1N1). The flu pandemic of 1918 has been considered one of the most severe disease events in known history, due to its worldwide impact.

Some forms of previous viruses continue to circulate worldwide as seasonal influenza viruses that have undergone mutation or *antigenic shift,* which changes the virus's genes. Viruses that have undergone *antigenic drift* result in small changes in the virus, which is why people can get the flu more than one time. It is also the primary reason why flu vaccine composition must be reviewed and updated annually (or as needed) to keep up with evolving influenza viruses.

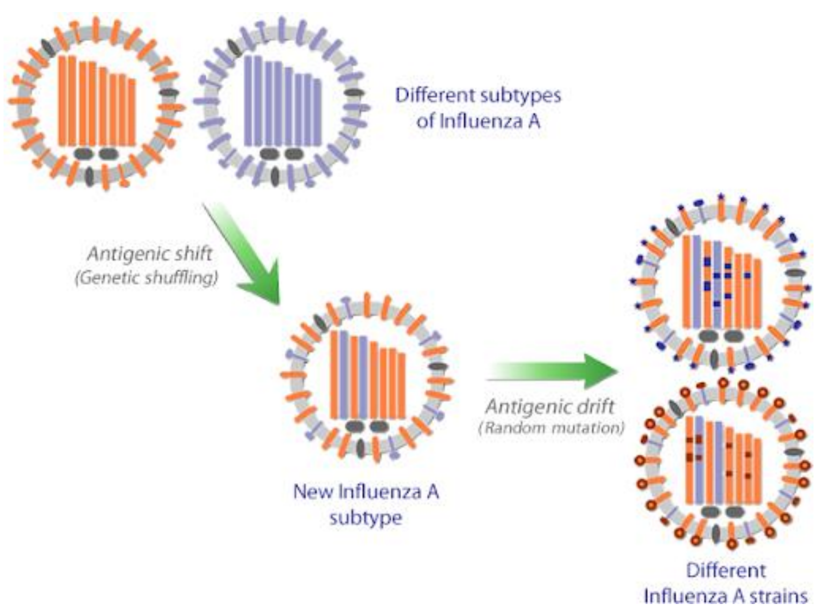


Figure 4.5.1: Antigenic Shift and Antigenic Drift[125]

Coronavirus

Coronaviruses are a large family of viruses that are common in people and many different species of animals, including camels, cattle, cats, and bats. Rarely do animal coronaviruses infect people and then spread person-to-person; however, they can mutate to human spread, causing respiratory illness (like the flu) with symptoms such as a cough, fever, and in more severe cases, difficulty breathing and pneumonia.

Previous pandemics involving coronaviruses include the severe acute respiratory syndrome (SARS) outbreak, which appeared in China in 2003 and spread to over 8,000 people worldwide and killed almost 800. In addition, the Middle East Respiratory Syndrome (MERS) was another coronavirus (MERS-CoV) that developed in 2012, with the first cases reported in Jordan. Most reported cases were linked through travel to, or residence in, countries in and near the Arabian Peninsula. However, the largest known MERS outbreak outside of that area was in the Republic of Korea in 2015. Transmission was noted to be from those having close contact, such as caring for or living with an infected person. MERS patients ranged in age from younger than one year to 99 years old. Public Health agencies continue to investigate clusters of MERS in several countries.

In late 2019, the new SARS-CoV-2 coronavirus, named "COVID-19", caused a quickly-spreading, widespread outbreak that quickly led to a pandemic. Within four months of first being identified, the virus spread worldwide with close to one million cases and more than 50,000 deaths. Because of the dynamic situation related to this virus, including evolving mutations, the long-term clinical picture with COVID-19 is not yet fully known as of this Plan update.

Ebola Virus Disease (EVD)

- Ebola is a rare but severe and sometimes deadly hemorrhagic fever virus most commonly affecting people and nonhuman primates (gorillas, monkeys, and chimpanzees), primarily in the sub-Saharan region of Africa. Ebola is spread through direct contact with body fluids or people infected with it or by touching things that have been contaminated with these fluids. Case fatality rates have varied from 25 to 90 percent in past outbreaks, with an average fatality rate of about 50 percent.
- No licensed treatment or vaccine is currently available for use in people. However, there are experimental treatments/vaccines in use.
- During the 2014 Ebola outbreak, of eleven reported cases in the United States, four were laboratory-confirmed cases in the United States, and seven cases were medically evacuated from other countries. Nine of those cases resulted in death; two recovered; and several additional expected cases were monitored in 2015 after possible exposure.

Measles, Mumps, and Smallpox

[125] World Health Organization.

- While measles, mumps, and smallpox have generally been eradicated in the United States' population through mass immunization measures, there are still episodes of local outbreaks that have the potential to lead to an epidemic scale, especially if community immunity levels decline in future years.

  Although no new cases of measles were reported in Vermont in 2019 (the most recent year for which data was identified), the number of cases of measles in the U.S. has been increasing over the past ten years, with 63 cases reported in 2010 and 1,282 cases in 2019, the highest number of cases reported in the United States since 1994 and since measles was declared eliminated in 2000. Most cases were among people who were not vaccinated against measles. Vaccination is the primary method of containing measles, which is the reason that it is more likely to spread and cause outbreaks in communities where groups of people are unvaccinated[126].

- Reported mumps cases in the United States, between 2000 and 2001 peaked in 2006 with a reported 6,584 cases, and again in 2016 with 6,366 cases. Since 2016 it has declined with the 2021 case numbers being the lowest in the past twenty years. However, as of November 10, 2021 the Centers for Disease Control and Prevention (CDC) reported that mumps cases were rising, even in vaccinated children, with 122 cases reported by 30 municipalities across the United States. There were no reported cases in Vermont at that time[127].

- Although there are still pockets of smallpox outbreaks in some countries, it has been considered to be almost eradicated worldwide.

Foodborne and Waterborne Diseases

Foodborne and waterborne diseases may be caused by food or beverages that contain harmful bacteria, parasites, viruses, or chemicals. In general, responses to these types of illnesses are components of a robust, multi-level surveillance system that integrates state and local medical systems and public health agency tracking in coordination with the CDC's monitoring systems. Some of these systems have been used extensively for decades, and frequent updates in the surveillance methods continue to improve the quality, quantity, and timeliness of its data. Because of this well-coordinated system and the low potential for widespread outbreaks related to bacterial and parasitic pathogens, foodborne and waterborne diseases are not addressed further in this plan as a potential pandemic event.

[126] Centers for Disease Control and Prevention, 2020.
[127] Centers for Disease Control and Prevention, November 10, 2021; https://www.cdc.gov/mumps/outbreaks.html

Table 4.5.1: Human Infectious Disease Hazard Profile Summary

HUMAN INFECTIOUS DISEASE Risk Assessment: Medium	**Location**: All county locations. **Extent**: Depending on how widespread and affected population, major impact on healthcare system. **Duration**: Weeks to months or years **Probability**: Medium **Seasonal Pattern**: Varies by disease type, such as fall flu season. **Speed of Onset:** Days to weeks **Warning Time:** Moderate **Repetitive Loss:** Not applicable	*Potential Cascading Effects* • Threat to health and safety • Vulnerable populations may be more significantly impacted • Responder health and safety • Disruption of critical services • Increased security • Major redirect of medical services and resources • Commodity shortages • Direct and indirect economic loss

Location

All communities within Chittenden County are susceptible to human infectious disease outbreaks. Variability in types of viruses, exposure, and social and environmental conditions make it difficult to predict specific locations of disease occurrences; however, in person-to-person transmission of an infectious disease, locations where humans are in close contact are more likely to be sites that lead to multiple cases, especially if airborne transmission is the primary means of exposure. Densely populated communities are typically more likely to have higher case numbers than rural areas. Some of the most significant outbreaks during the COVID-19 coronavirus outbreak have been noted within residential healthcare facilities, such as long-term care/assisted living facilities and large employers where workers are in close proximity to each other.

Extent

Human infectious disease outbreaks can impact widespread areas, straining the healthcare system, and resulting in limited access to medical care, reduced inventories of critical medications, medical supplies and equipment; and the need for monitored or controlled countermeasures, such as isolation, quarantine, and vaccination. The medical community may be challenged by the need to provide adequate care for many people simultaneously while conducting public education campaigns to share timely preventative information. The following definitions guide public health officials in planning prevention/preparedness, response, recovery, and mitigation measures for human infectious disease:

Table 4.5.2. Human Infectious Disease Outbreak Levels[128]

Disease Level	Definition
Sporadic	When a disease occurs infrequently and irregularly

[128] Centers for Disease Control and Prevention (CDC)

Disease Level	Definition
Endemic	The baseline level of disease, marked by constant presence or usual prevalence of a disease or infectious agent in a population within a geographic area
Hyperendemic	Persistent, high levels of disease occurrence
Epidemic **(Or *Outbreak*, used for a more limited geographic area)**	An increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area
Pandemic	An Epidemic that has spread over several countries or continents, usually affecting a large number of people

Epidemic

An epidemic can result from illnesses including, but not limited to, influenza, meningitis, measles, and tuberculosis. An epidemic does not have to be a contagious disease. Conditions such as cancer, West Nile fever, and obesity are epidemic if they affect many of the population at the same time. There are two main sources of infectious disease epidemics, and some epidemics have characteristics that are common to both:

- **Common Source Outbreak:** Affected individuals are exposed to a common agent. The exposure can be singular, meaning that all affected individuals develop a disease following a single exposure and incubation course (also called a point source outbreak), or exposure may be continuous and variable with multiple, intermittent exposures to the source.

- **Propagated outbreak:** Disease is spread person-to-person and affected individuals may become independent reservoirs that lead to further exposure.

Pandemic

This plan focuses on human infectious disease outbreaks that result in a pandemic. Other levels of disease outbreaks, including epidemic, are generally considered manageable within the capacity and capabilities of local resources, including mutual aid. For planning purposes, pandemic outbreaks are considered as "worst-case scenarios," and appropriate mitigation actions that address pandemic conditions would also support outbreaks of lesser magnitudes.

A pandemic event represents a public health emergency impacting all sectors of society. Its occurrence is also unique because, although it has been rare in the past, it has been considered inevitable and over the past two decades has led to extensive preparedness and planning measures at all levels of government.

A pandemic event resulting from a viral outbreak occurs when a significant antigenic drift, or shift, occurs in the virus, resulting in a new or "novel" strain spreading efficiently from person-to-person, to which the population has not been exposed, and there is no underlying immunity. The severity of the outbreak event is generally variable and unpredictable.

Many infectious disease cases will increase the burden on hospitals and other healthcare system resources and infrastructure. Morbidity and mortality may disproportionately impact younger and healthier people (as was experienced with the influenza pandemic in 1918) or may impact older and medically-at-risk people (as initially occurred in the coronavirus outbreak in 2020). This may reduce the availability of workers due to worker illness, isolation/quarantine, or workers caring for those who are ill. It may also restrict normal activities of the population and result in shortages or unavailability of commodities. Mitigation strategies, such as "stay-at-home" orders and closure of nonessential businesses, may decrease opportunities for disease transmission but will also likely create additional burdens upon the productivity of the workforce and availability of essential goods and services.

Some viruses that have led to epidemics or pandemics in the past sometimes become endemic, meaning they remain prevalent in the population at some level and are controlled through multiple public health mitigation measures such as surveillance, isolation/quarantine, or mass prophylaxis.

Previous Occurrences

There are legal limitations on the availability of medical information related to cases of human infectious disease. The state and local public health and medical systems closely monitor and coordinate specific reportable diseases that indicate current cases. However, laws that protect private medical information, such as the Health Insurance Portability and Accountability Act (HIPAA), constrain all disease-related data-sharing. During a public health emergency, the HIPAA privacy rules are not suspended. However, the Secretary of the U.S. Department of Health and Human Services (DHHS) may waive certain provisions, sanctions, or penalties during the emergency. Local and state health officials who maintain records documenting outbreaks and the prevention and containment actions taken must continue to consider the HIPAA provisions related to an individual patients' right to privacy during the emergency.

Trends in specific disease outbreaks are coordinated through public health agencies. They may rise to the level of public health alerts, warnings, or emergencies. State and local health officials continuously coordinate with other government agencies to maintain the highest level of preparedness and response possible.

For mitigation planning, three human-infectious disease outbreaks of a pandemic or widespread level are considered:

- 1918 Spanish Influenza
- 2009-2010 H1N1 Influenza
- 2020 COVID-19 (coronavirus) Pandemic

The State of Vermont, including Chittenden County and its' municipalities, has received two (2) Federal Disaster Declarations related to human infectious disease since 1964, both related to the current COVID-19 outbreak in 2020. This event is the only widespread human infectious disease outbreak since the 2017 Plan.

Table 4.5.3. Federal Disaster Declarations for Human Infectious Disease, Chittenden County (1964 - 2021)[129]

Disaster Number	Event Type Individual Assistance (IA) Public Assistance (PA)	Declaration Date	Damage Amount
DR-4532-VT	***Vermont Covid-19 Pandemic (All counties)*** Chittenden – IA, PA (Category B)	April 8, 2020	FEMA Obligated Dollars as of 12/3//2021 IA - $417,859.04 (72 households) PA - $287,140,208.76
EM-3437-VT	***Severe Storms and Flooding (All counties)*** Chittenden – PA (Category B)	March 13, 2020	FEMA Obligated Dollars as of 12/3/2021 PA – UNAVAILABLE

Probability of Future Events

Based on the historical occurrence of human infectious disease outbreaks of a pandemic level in Vermont and Chittenden County, it can be estimated that the recurrence interval is 34 years[130], indicating that, on average, a human infectious disease event will occur within that time period.

An influencing factor in quantifying the probability of future events is predicting when an infectious disease outbreak or pandemic transitions to an endemic and the prevalence of the disease remains in the local population.

Influence of Climate Change

Studies and reports on climate change indicate a relationship between changing climate conditions and the potential for increased human disease activity. Scientific projections suggest an increase in many extreme events in response to a warming climate, such as heavy precipitation events, which could ultimately result in changing environmental conditions that exacerbate the impact on public health. Because climate models are not in full agreement on the type or amount of change, this is still an active area of research that should be monitored in the next planning cycle.

Intervention and Prevention

A few Human Infectious Diseases that have been pandemics in the past or had the potential to become a pandemic, such as smallpox and measles, have been successfully controlled by comprehensive vaccination programs. Other diseases, such as Ebola and other hemorrhagic

[129] Federal Emergency Management Agency (FEMA)
[130] Statistical calculation based on 103 years of record with three events between 1918 and 2021.

fever diseases remain a threat monitored through international, national, and local surveillance systems.

The public health system functions at all government levels and in collaboration with private-sector partnerships. Federal, State, and county-level public health agencies continually communicate and coordinate efforts to identify health threats. They also share information about outbreaks, new practices and protocols, and preventive measures.

The public health system uses multiple control activities to reduce the transmission of infectious diseases. There are multiple steps involved in identifying an outbreak, preventing additional exposure, and providing treatment. Other steps may be incorporated into this process, depending on the type of disease and available resources.

Table 4.5.4. Communicable Disease Monitoring and Containment

Measure	Description
Disease Surveillance Systems	• Maintained by health epidemiology officials and staff, supported by healthcare facilities and providers • Require reporting of specific communicable diseases by medical providers, schools, healthcare facilities, residential facilities, and sometimes the general public • Aid in quickly identifying potential outbreaks and establishing medical countermeasures to prevent widespread transmission • Implement contact tracing and investigation to identify paths of transmission
Protective Actions, including Public Education and Information	• Public notification or alert, when appropriate • Dissemination of educational materials describing appropriate measures to prevent exposure/illness • Expedited public information to manage perceptions and reduce fear • Isolation (separation from other persons when an individual may have the infectious disease) • Quarantine (prohibiting non-medical persons from entering or leaving premises where a case of a communicable disease is receiving treatment or contained for "social distancing" purposes)
Medical Countermeasures	• Mass prophylaxis (medication/vaccination to large numbers of prioritized groups, such as responders, vulnerable populations, or the public) • Mass distribution of personal protective equipment (PPE) • Deployment of mass patient care system/Alternate Care Sites to reduce medical surge • Deployment of Strategic National Stockpile (SNS) assets as needed.

The Strategic National Stockpile (SNS) is a federal repository of medical supplies maintained by the U.S. DHHS to supplement state and local medical response operations during public health emergencies. Supplies include personal protective equipment, antibiotics, vaccines, chemical antidotes, antitoxins, and other critical medical equipment and supplies. The SNS is designed to be a short-term stopgap buffer when state or local supplies of these materials are not immediately available. The SNS is activated upon request by a state and approval by the U.S. DHHS. Additional resources are available through the State of Vermont, if requested.

Figure 4.5.2. Strategic National Stockpile Warehouse[131]

The Vermont Department of Health (VDH) is the state's lead agency for preparedness, response, recovery, and mitigation of events that affect community health or medical needs. The Vermont Statues, Title 18: Health, Chapter 021, addresses provisions for communicable diseases, and the Vermont Administrative Procedures Act, Chapter 4, defines the department's process for reporting communicable diseases.

4.5.2 RISK ASSESSMENT

of the risk level related to human infectious disease impacts the public, responders, continuity of operations and services, property, infrastructure, environment, economic conditions, and the public's confidence in governance.

Table 456.5. Human Infectious Disease Impacts and Consequences

Human Infectious Disease Impact/Consequence Summary	
Public: Housing, Casualties, Fatalities, Work, Food, Water	Housing - depending on the scale and magnitude of the outbreak conditions, residents could be quarantined within their homes, requiring support for food, medical care, and other essentials. Transient residents may require temporary housing for health and security. Casualties/Fatalities – may be significant, especially with at-risk and vulnerable populations and healthcare workers. Additional resources for medical care and mortuary services may be required. Food/water – impact

[131] Centers for Disease Control and Prevention, U.S. Department of Health and Human Services: Accessed at www.cdc.gov/phpr/stockpile/index.htm

Human Infectious Disease Impact/Consequence Summary	
	could be high if significant sectors of the economy are reduced or shut down temporarily. Support may be needed to produce or deliver commodities to the population. Those individuals experiencing food insecurity during a non-pandemic event may face increased challenges in obtaining food/water.
Responders: Fire, Police, Medical, Public Works	Depending on the scale of the event, response agencies are highly likely to be severely impacted, requiring additional workforce, mutual aid, security, and other resources to continue essential services. High impacts on community health and medical systems, including residential medical facilities, can be expected along with increased demand for personal protective equipment (PPE).
Continuity of Operations	Impacts on operational continuity are likely to be related to insufficient personnel to carry out mission essential functions, resulting in the need for mutual aid, volunteers, or other personnel support. Operational continuity may be impacted for multiple short-term periods or may occur over an extended time.
Property: Destroyed, Major, Isolated	Residential and commercial properties are unlikely to be impacted by a human infectious disease outbreak.
Infrastructure: Electricity, Water, Roads, Bridges	Transportation may be indirectly impacted due to the limitation of personnel, restricted operations, or prioritization of other transportation missions. Electricity, water, roads, and bridges are less likely to be impacted unless personnel are unable to fulfill essential functions and services due to illness or other restrictions.
Environment	Limited to no impact expected.
Economic Conditions	Depending on the outbreak's scale and magnitude, there could be high impacts on the local, national, and global economies. The productivity of industrial and commercial entities may be limited or redirected to support essential functions or services. Agriculture production may be reduced based on personnel impacts on operations and a decline in marketable goods. Restrictions on business operations will also create significant impacts on the economy, potentially resulting in permanent closure of many large and small businesses leading to high levels of unemployment. Every sector of the economy will most likely experience the negative effects of a long-term pandemic.

Human Infectious Disease Impact/Consequence Summary	
Public Confidence in the Governance	Confidence is likely to be highly impacted as citizens will expect the government to effectively conduct disaster operations and return the community to a normal state within a reasonable time. Failure to do so may lead to cascading events such as incidents of civil unrest. In addition, citizens will expect timely and reliable public information issued from a trusted source, and widespread instances of rumors or disinformation may confuse the appropriate protective measures expected from the public.

Hazard Risk Ranking

Each jurisdiction in the Planning Area conducted a risk analysis to consider impacts, consequences (including magnitude/severity), and probability of future occurrences to determine the Overall Risk Rating for human infectious disease.

Table 4.5.6: Human Infectious Disease Hazard Risk Rating Summary, All Municipalities

JURISDICTION	Sum - Impact/ Consequence Score	Probability	Total Risk Rating *(Impact/ Consequences x Probability)*	Hazard Ranking
Bolton	7	3	**21**	**Medium**
Buels Gore	6	1	**6**	**Low**
Burlington	6	1	**6**	**Low**
Charlotte	6	3	**18**	**Low**
Colchester				
Essex	7	3	21	**Medium**
Essex Junction	7	3	21	**Medium**
Hinesburg	7	3	**21**	**Medium**
Huntington	2	1	**2**	**Low**
Jericho	5	3	**15**	**Low**
Milton	6	4	**24**	**Medium**
Richmond	7	3	**21**	**Medium**
Shelburne	7	3	**21**	**Medium**
South Burlington	7	3	**21**	**Medium**
St. George	7	3	**21**	**Medium**
Underhill	7	3	**21**	**Medium**
Westford	7	4	**28**	**Medium**
Williston	10	3	**30**	**Medium**
Winooski	8	3	**24**	**Medium**
AVERAGE SCORE			**19.1**	**Medium**

The compilation of jurisdiction risk scores, along with consideration of the hazard profile and potential impacts and consequences, indicates that **human infectious disease** is a **medium-**

risk hazard for thirteen municipalities, and a **low-risk** hazard for five municipalities within the Planning Area. Consequently, a vulnerability assessment is appropriate to identify the level of exposure to the municipalities within the Planning Area.

4.5.3 VULNERABILITY ANALYSIS

A widespread pandemic would significantly impact the population and multiple Community Lifelines that support the well-being of the population, including Safety and Security; Food, Water and Shelter; and Health and Medical. It is unlikely that there would be significant impacts on other Community Lifeline sectors, except in catastrophic circumstances where essential workers within the other sectors were impacted by the disease outbreak and unable to work.

Safety and Security

The government service and community safety elements within this Lifeline sector could be adversely impacted by a pandemic if the public perception is that elected officials and other subject matter experts are not adequately addressing the needs of the population. This, in turn, could lead to civil unrest, and disruption of government functions.

Food, Water, and Shelter

A widespread disease outbreak, or threat of exposure to a disease, such as that seen in some phases of COVID-19, could result in the closing of vital businesses such as grocery and other retail stores, as well as schools, and daycare centers. The supply chain could also be affected to the point that basic food items, and medicine, medical equipment, and personal protective equipment such as surgical masks, gloves and sanitizers are in short supply or unavailable.

Health and Medical

Immunization rates in Chittenden County provide a reliable indicator of vulnerability of the population to multiple infectious diseases.

Table 4.5.7. Immunization & Infectious Disease, Chittenden County[132]

Healthy Vermonters 2020 Indicator	County Baseline	County Current	VT Current	U.S. Current	Target
Percent of children aged 19-35 months receiving recommended vaccines	34% (2010)	71% (2015)	76% (2015)	72%	80%
Percent of kindergarteners with 2 or more MMR doses	N/A	N/A	94% (2015)	95%	95%
Percent of adolescents aged 13-15 who have completed the HPV vaccination series	29% (2013)	38% (2015)	33% (2015)	N/A	80%
Percent of adolescents aged 13-17 with at least 1 Tdap booster	72% (2010)	82% (2015)	96% (2015)	86%	90%

[132] Healthy Vermonters 2020 Quick Reference, Chittenden County; HV2020_counties_quick_reference.xlsx (healthvermont.gov)

Healthy Vermonters 2020 Indicator	County Baseline	County Current	VT Current	U.S. Current	Target
Rate of varicella (chicken pox) per 100,000 Vermonters aged 17 or younger	N/A	N/A	19.1 (2015)	197.0 (2013)	46.4%
Percent of adults aged 65 and older who receive annual flu shot	67% (2011-12)	65% (2014-15)	61% (2015)	61%	90%
Percent of adults aged 65 and older who ever had pneumococcal vaccine	72% (2011-12)	79% (2014-15)	76% (2015)	71%	90%
Percent of identified active TB case contacts with newly-diagnoses LTBI who started then completed treatment	N/A	N/A	95% (2015)	66% (2012)	90%
Infection ratio for central-line associated bloodstream infections	N/A	N/A	0.13 (2013)	*0.54	15%

Because the COVID-19 outbreak is occurring simultaneously with this Plan update, the vulnerability analysis for this update is based on the most recently available data for this disease as a “reasonable scenario” for a widespread pandemic.

COVID-19 PROFILE

COVID-19 first made its appearance in the United States in March 2020, causing the start of a nationwide pandemic. At that time it was already becoming a worldwide pandemic, originating in Wuhan China, and rapidly spreading. Like the rest of the U.S, Vermont was involved in a widespread, three-month shut down with only a few resources open to the public, such as grocery stores, gas stations, and some fast food and occasional retail stores like Walmart and Target. As of November 2021, Vermont, like most states had reopened schools, businesses, and other gathering locations but was still cautiously monitoring new mutations and following CDC guidelines to help stop the continuing spread of this disease. As of January 2021, there were three approved vaccines, first available for older adults and those with certain health conditions, eventually including young adults ranging from the ages of 12 to 30. As of November 2021, there had been one approved vaccine for children ages five to eleven that will start providing data on its efficacy. At the time of publication of this update, two COVID-19 booster vaccinations were also offered to already-vaccinated adults.

The Vermont Department of Health statistical reports, as of October 20, 2021, indicated the number of county residents vaccinated, community transmission rates, and number of cases, by town.

Table 4.5.8: COVID-19 Vaccination in Chittenden County, Vermont (October 25, 2021)[133]

[133] Centers for Disease Control and Prevention, COVID Data Tracker, CDC COVID Data Tracker

People Vaccinated	At Least One Dose	Fully Vaccinated
TOTAL	118,310	105,699
% of Total Population	72.2%	64.5%
Population ≥ 12 Years of Age	118,165	105,683
% of Population ≥ 12 Years of Age	81.3%	72.7%
Population ≥ 18 Years of Age	110.174	98,488
% of Population ≥ 18 Years of Age	81.5%	72.8%
Population ≥ 65 Years of Age	23,652	22,118
% of Population ≥ 65 Years of Age	92.8%	86.8%

Table 4.5.9: COVID-19 Community Transmission Rates, Chittenden County, Vermont (Oct. 25th, 2021)[134]

Cases	296
Cases Rate per 100K	180.74
% Positivity	2.33%
Deaths	<10
% Eligible Population Fully Vaccinated	72.7%
New Hospital Admissions	9

Table 4.5.10: Municipal COVID-19 Counts from 03/05/2020 through 10/20/2021[135]

Municipality	Count
Bolton	352
Burlington	3,435
Charlotte	138
Colchester	1,094
Essex/ Essex Junction	1,219
Hinesburg	217
Huntington	78
Jericho	241
Milton	739

[134] Ibid.

[135] Vermont Department of Health, COVID-19 Rates by Town; [Rates by Town | Vermont Department of Health (healthvermont.gov)]

Richmond	141
Shelburne	279
South Burlington	879
St. George	39
Underhill	98
Westford	77
Williston	552
Winooski	701

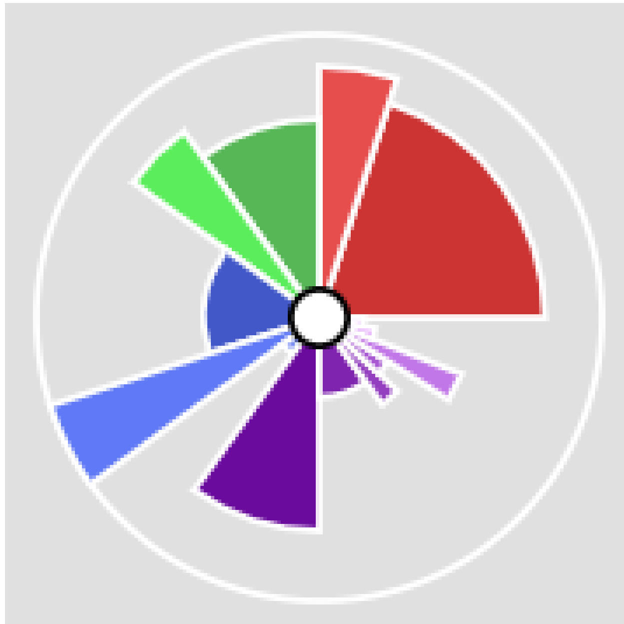
As of November 27, 2021, 375 deaths in Vermont had been attributed to COVID-19.

Lessons Learned

- The spread of the COVID-19 virus could have been limited through early widespread access to accurate testing, and implementation of early social distancing measures, including travel restrictions.
- Health and medical systems are quickly overburdened and lack vital equipmentm, including personal protective equipment (PPE) to respond to the number of critical patients.
- Coordination between multiple levels of government and agencies is essential to address the care capacities and availability of critical staff and other resources needed by hospitals and care centers.
- "Stay-at-home" orders have a significant impact on the economy, increasing unemployment and the need for government support for workers and businesses.
- Schools and businesses must rely on alternative methods for continued operations and services.

COVID-19 Pandemic Vulnerability Index

The CDC has developed a COVID-19 Pandemic Vulnerability Index (PVI) (with and without Vaccine Model) for U.S. counties that evaluates the level of vulnerability based on multiple community factors. Chittenden County has a PVI with Vaccine Model score of 0.54, which indicates a rank in the 60-40 percentile, or medium risk.



1	Infection Rate Transmissible Cases	0.78
2	Infection Rate Disease Spread	0.88
3	Pop Concentration Pop Mobility	0.67
4	Pop Concentration Residential Density	0.79
5	Intervention Vaccines	0.34
6	Intervention Social Distancing	1.00
7	Intervention Testing	0.07
8	Health & Environment Hospital Beds	0.72
9	Health & Environment Hospital Ventilators	0.20
10	Health & Environment Pop Demographics	0.31
11	Health & Environment Air Pollution	0.21
12	Health & Environment Age Distribution	0.49

Figure 4.5.3. CDC Pandemic Vulnerability Index with Vaccination Model[136]

Public Health Monitoring and Prevention Measures

Outbreaks may erupt at any time in pockets of the population. Public health and medical systems have established monitoring thresholds, surveillance procedures, and treatment regimens based on infectious disease characteristics. These approaches incorporate the most recent medical evidence around etiology (how they start) and transmission (how they spread).

[136] Centers for Disease Control and Prevention, COVID-19 Pandemic Vulnerability Index; https://covid.cdc.gov/covid-data-tracker/#pandemic-vulnerability-index

They are specific to geography, climate, availability of medical care, and social practices.)ne type of model that is in use for the rapid detection of the infectious disease, influenza, is illustrated.

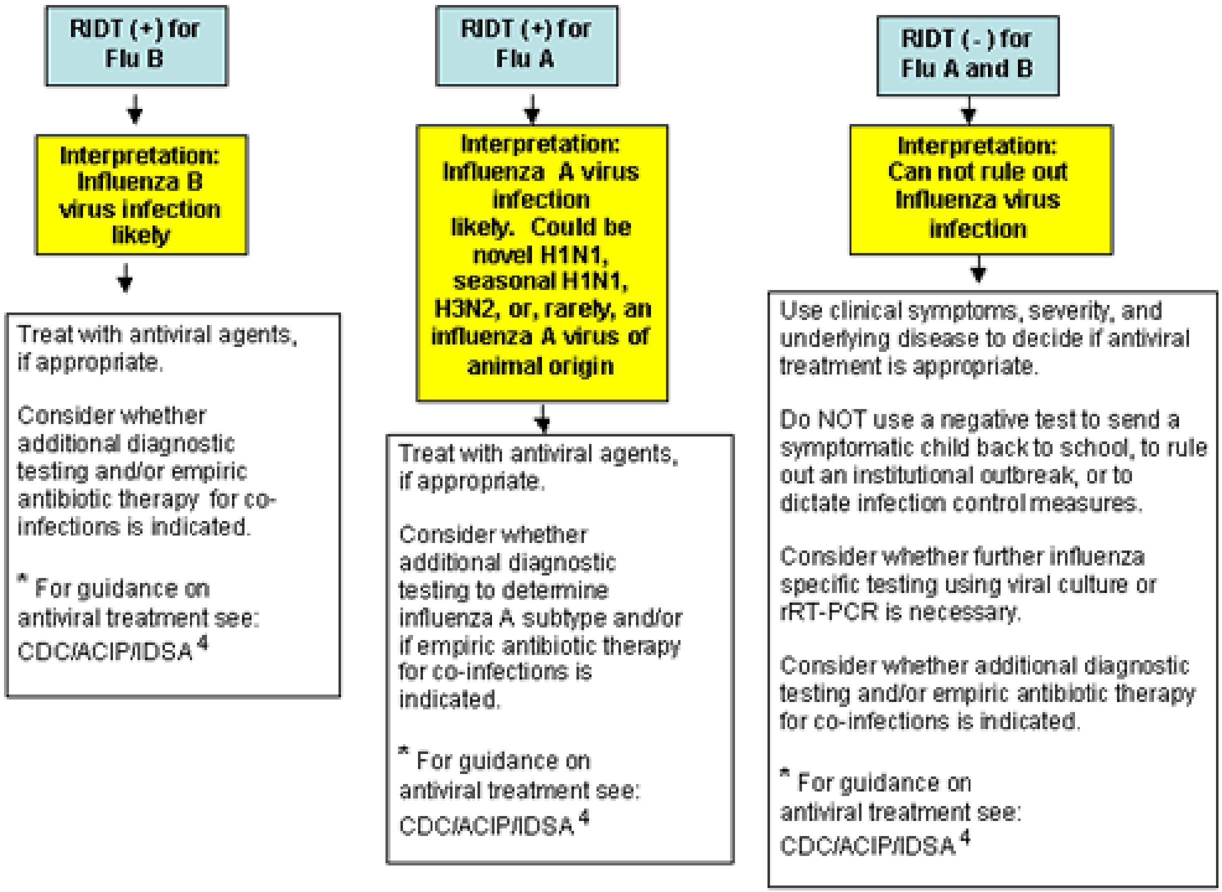


Figure 4.5.4. Algorithm to Assist in Interpretation of Rapid Influenza Diagnostic Test (RIDT)3[137]

Measures to contain or prevent human infectious disease outbreaks are *non-pharmaceutical* and *pharmaceutical*. In general, *non-pharmaceutical* measures are most effective in preventing the spread of a viral outbreak unless a vaccine has been developed and is found to be effective in preventing infection. *Non-pharmaceutical* interventions include:

- Social distancing and personal protection (limiting public gatherings, restricting travel, instituting isolation or quarantine, wearing protective equipment)
- Contact Tracing (investigating chains of exposure and potential transmission through individual and group contacts)

---

[137] Interim Guidance for the Detection of Novel Influenza a Virus Using Rapid Influenza Diagnostic Tests, CDC, August 10, 2009 https://www.cdc.gov/h1n1flu/guidance/rapid_testing.htm; accessed 05/07/20

- Aggressive testing (confirming cases so that social distancing or medical treatment can limit or prevent transmission to additional people)

Medical countermeasures, or *pharmaceutical intervention*, emphasize the prevention of influenza and corona-type viruses through immunization and targeted use of appropriate and antivirals approved by the Federal Drug Administration (FDA) as treatment. Limited use of prophylaxis may be carried out for specific, exposed, high-risk populations. The expected time required to develop effective vaccines for specific viruses may take six months or longer. Additional lag times associated with the vaccine's development and availability in sufficient quantities for the total population must also be anticipated. The challenge to this measure is the almost certainty that a virus will mutate or undergo antigenic changes requiring the development of new vaccines that effectively address these changes. In addition, antivirals may be of limited value as resistance to these drugs has been noted in many previous seasonal and novel virus cases.

Future Population and Development Trends

Human infectious disease is not limited to geographic boundaries or the built environment. Still, it may be influenced by changes in population density or demographics. For that reason, it is difficult to identify development and population trends that may impact the level of risk to this hazard. Current public health and medical systems incorporate standards that address and mitigate human infectious disease outbreaks to some extent; however, contagion between agricultural animals and humans is problematic with potential changes in the climate, and human-to-human infections such as HIV, tuberculosis, and measles is also expected to change with population shifts. Other factors that may increase exposure to infectious diseases include:

- Venues and locations where individuals are in close contact with large numbers of people. Examples include public buildings, businesses, schools, churches, sports events, concerts, and special events.
- Presence of at-risk populations such as those with specific medical conditions. Examples include residential medical facilities such as nursing homes or assisted living residences.
- Presence of vulnerable populations, such as those living in densely populated conditions. Examples include multi-generational and multi-family residences, housing with common heat or air conditioning systems such as university or college dormitories, or populations without access to healthcare services.

The potential for impacts on future growth and development of human infectious disease will be monitored and evaluated in the next planning cycle to determine whether the level of risk has changed and whether there are opportunities for mitigation related to development that could reduce hazard impacts in the future.

Factors for Consideration in the Next Planning Cycle

Future monitoring, evaluation, and update of this plan should consider the following factors related to human infectious disease as well as other information from the SHMP updates:

- Monitor and update COVID-19 impacts and consequences to local municipalities.
- Have any new human infectious disease threats or events occurred since the adoption of this plan?
- Has any new scientific research or methodology changed the ability to predict/control human infectious disease events or assess risk and vulnerability?
- Has there been any significant change in the population, built environment, natural environment, or economy that could affect the risk or vulnerability to human infectious disease?
- Is there any new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to human infectious disease?

4.6 Invasive Species

2022 MJAHMP Update
The 2022 plan update expanded this hazard profile to provide a more comprehensive source of information about the hazard and its impacts. In addition, the risks and vulnerabilities related to the hazard are noted to have increased since the 2017 Plan. In order to elevate the importance of the hazard, the profile was moved from the Technological Hazards category to the Natural Hazards category to reflect causes and increased impacts in the planning area. Additional changes include, but were not limited to: • Reexamining the Invasive Species hazard characteristics. • Expanding the hazard profile. • Researching data sources to identify information related to occurrences. • Updating the assessment of risk and vulnerability by jurisdiction based on new data and ranking the hazard by jurisdiction using the methodology described in detail in Section 4 Ranking and Analysis Methodologies. • Reformatting the section to improve clarity and, as available and appropriate, incorporate new maps and imagery.

Invasive Species					Overall Vulnerability
Definition, Key Terms, and Overview					MEDIUM
An invasive species is any living organism such as a bacterium, protist, fungus, plant, or animal, that has been introduced to an environment where it is not native, and that has since become an environmental or economic nuisance through rapid spread and increase in numbers, often to the detriment of native species. They can also harm human health[138].					
Frequency	Probability	Potential Magnitude			
		Injuries/Deaths	Infrastructure	Environment	
Moderate	Moderate	Low	Low	Moderate	

4.6.1 Hazard Profile

A 2021 study by the United States Department of Agriculture estimated that invasive species have cost over $26 billion per year in the U.S. since 2010[139]. Invasive species can be plants, animals, and other living organisms, such as microbes. They are typically non-native to the ecosystem in which they are found and their introduction causes or are likely to cause impacts to the environment, economy, and public health.

This profile examines land-borne and aquatic invasive species known to be present in the planning area:

Land-Borne Invasive Species (Tree Pests):

[138] United States Department of Agriculture, National Invasive Species Information Center. Retrieved at: https://www.invasivespeciesinfo.gov/what-are-invasive-species

[139] Crystal-Ornelas R., E.J. Hudgins, R.N. Cuthbert, et al. 2021. Economic costs of biological invasions within North America (link is external). NeoBiota 67:485-510. Retrieved at USA National Invasive Species Information Center website: https://www.invasivespeciesinfo.gov/subject/economic-and-social-impacts

Although most of the species highlighted in this plan have not yet reached crisis proportions in the planning area, some have already caused municipalities to expend resources to control or eliminate their spread. Given their potential impacts to the natural resources valued in the county, this profile was expanded for the 2022 update and moved to the Natural Hazards category to emphasize its importance. If the management of invasive species requires substantial programmatic efforts, the impacts to the budgets of municipalities, service providers (such as water service operators) and taxpayers could be significant. Tree Pests that are impacting, or have the potential to impact the planning area include, but are not limited to:

Asian Longhorned Beetle (ALB)[140]

The first North American discovery of the ALB was in New York City in 1996, and a large infestation was found in Worcester, MA, 45 miles from Vermont, in 2008.

This insect, with six legs and approximately one to one and a half inches in length, has a shiny jet-black body with distinctive white spots, long antennae (longer than their body), and are banded in black and white. ALB larvae can be up to 2.5 inches long. They are creamy white with no legs and have a hard brown plate on their head.

Figure 4.6.1: Asian Longhorned Beetle. Photo credit: Vermont Agency of Natural Resources.

Adult beetles emerge from hardwood trees from July to September and leave round, dime-size exit holes. Egg laying sites may ooze sap or be healed over and knot-like. Other signs of infestation include sawdust or frass in branch crotches and at the tree base, and dead or fallen branches.

ALB host species include; ash, birch, elm, golden raintree, sycamore, maple, horse chestnut, katsura, mimosa, mountain ash, poplar, and willow. The Asian Longhorned beetle is most threatening to hardwood trees, including recreation and forest resources (like maple syrup) which are valued at billions of dollars. The ALB has the potential to cause more damage than Dutch elm disease, chestnut blight, and gypsy moths combined.

Emerald Ash Borer (EAB)[141]

[140] United States Department of Agriculture, Animal and Plant Health Inspection Service, Asian Longhorned Beetle. Retrieved at: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/the-threat/asian-longhorned-beetle/asian-longhorned-beetle
[141] United States Department of Agriculture, Animal and Plant Health Inspection Service, Emerald Ash Borer Beetle. Retrieved at: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/the-threat/emerald-ash-borer/emerald-ash-borer-beetle

The Emerald Ash Borer (EAB) was first discovered in Vermont in February 2018, on private property in Orange County by a forester conducting a land management survey for the property owner. As of March 2022, EAB was detected in Chittenden County, in the Town of Richmond in October 2020, and followed by a detection in the Town of Colchester in May 2021.

Adult EABs are one-quarter to one-half inches long with a narrow, bullet shaped and a flat back. Adults are metallic in color with purple/red metallic abdominal segments beneath their wing covers. Larvae can get up to three centimeters in length and are a creamy white color with no legs. The larvae body is made up of flattened, bell-shaped segments.

Figure 4.6.2: Adult Emerald Ash Borer 1. Photo credit: Vermont Agency of Natural Resources.

Adult beetles emerge in late May or early June and can attack all species of ash trees. The damage pattern results in splitting bark with S-shaped tunnels behind outer bark, D-shaped exit holes one-eighth inches wide on the bark surface, and woodpecker-like flecking, Once the tree is invaded by the species, top branches die and leafy offshoots sprout from the lower trunk.

The Emerald Ash Borer probably arrived in the United States on solid wood packing material carried in cargo ships or airplanes originating in its native Asia. The Emerald Ash Borer feeds and lives in all species of ash and, in some cases, it has been found on white fringe trees.

The EAB generally has a one-year life cycle and goes through complete metamorphosis. Adults lay eggs on the bark of the trunk or branches in the summer and eggs hatch in seven to ten days. Larvae do their damage to the tree by tunneling in the inner bark and outer wood. This kills the tree by interrupting the flow of food and water.

The EAB is a significant threat to Vermont's ash trees as five percent of the state's trees are ash. Most ash trees infested with EAB will die, which poses a threat to Vermont's economy and ecology. It spreads very quickly, is difficult to detect, and eradication is not expected.

Hemlock Woolly Adelgid (HWA)[142]

[142] United States Department of Agriculture, Animal and Plant Health Inspection Service, Hemlock Woolly Adelgid Environmental Assessments, June 2, 2020. Retrieved at: https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/ea/ct_hwa

Hemlock woolly adelgid was observed in Virginia in the early 1950's and has now spread from Georgia to Maine. In 2007, it was found on native trees in Vermont for the first time. This species has caused widespread mortality of eastern hemlock trees by feeding on its sap.

Figure 4.6.3: White, cottony balls at base of hemlock needs. Photo credit: Vermont Agency of Natural Resources.

The HWA is a small, aphid-like insect that feeds on hemlock species in North America. It has "wool" attached to the twig of hemlock trees, not attached to the needles. HWA is immobile when covered in wax, and wispy. They produce white, cottony balls at the base of hemlock tree needles, causing the needles to turn yellow and fall out, followed by branch dieback, and crown thinning.

The HWA feeds on young twigs, causing needles to dry out and drop prematurely. Trees may die in four to six years. Some survive, but with sparse foliage, losing value as a shelter for wildlife and their ability to shade streams.

The HWA is spread by wind, birds, mammals, human activities, and the transport of infected nursery stock, creating an extreme amount of damage to natural stands of hemlock, specifically eastern hemlock, and Carolina hemlock. Biological controls are being used to reduce the impact of HWA spread across the landscape, including two biological control agents that have been used in Vermont, the *Laricobius nigrinus* beetle and the *Lecanicillium muscarium* fungus[143].

Aquatic Invasive Species (AIS)

Invasive species in water can be both animal and plants. Non-native animals are frequently pets released into waterways by people. The plants introduced into water can become overgrown and plant roots into the lake or riverbed causing death of the local plant life by strangling out their root systems to make room for their own roots to take hold and thrive. Given the importance of Lake Champlain to the county, AIS are the most significant in relation to the hazards included in the plan update. Species that negatively impact AIS include plants, animals, and pathogens that may be intentionally or unintentionally introduced to the Lake Champlain Basin include, but are not limited to:

Alewife (or Alewives)[144]

[143] Ibid.
[144] Vermont Invasives website, Alewife. Retrieved at: https://www.vtinvasives.org/invasive/alewife

Alewives are small members of the herring family with a dark, bluish to greenish dorsal side (top), a lighter colored ventral side (bottom) with darker horizontal stripes. In inland systems they rarely exceed 10 inches in length, with most adults in the five to eight-inch range. Other notable characteristics of this species are a black spot on the upper portion of the back behind the gill cover, and a lower jaw that protrudes past the upper jaw, which gives this species the appearance of having a slight underbite. Also, the belly is serrated.

Figure 4.6.4: Alewife. Photo credit: Vermont Agency of Natural Resources

Alewives are native to much of the eastern United States and were historically found from the Atlantic coast of Florida to the rivers of eastern Maine. Before their introduction into landlocked systems, all alewife populations in North America were anadromous, meaning they would spend most of their lives in saltwater and migrate into freshwater systems to spawn. Habitat degradation and other factors have threatened alewives in much of their native range, and there are efforts to restore alewives to East Coast rivers where spawning populations are now a fraction of what they once were. Introduced populations of alewives have been deemed invasive in landlocked systems in the East and Midwest, including the Great Lakes.

Eurasian Watermilfoil[145]

Eurasian watermilfoil is a submersed perennial plant, with feather-like leaves grouped in three to six whorls around the stem. Unlike native milfoils, each leaf is divided into paired leaflets with 10-20 pairs per leaf (native milfoils typically have less). As stems approach the surface, the individual stems branch several times. Eurasian watermilfoil shoots and new growth often have a reddish color close to the surface. This plant forms small flowers in July and August, which occur just above the surface and are reddish or pinkish in color.

[145] Lake Champlain Basic Program, Aquatic Invasive Species website. Photo credit: Allison Fox, University of Florida. Retrieved at: https://www.lcbp.org/our-goals/healthy-ecosystems/aquatic-invasive-species/ais-in-the-lake/#EuMil.

Figure 4.6.5: Eurasian Watermilfoil. Photo credit: Vermont Agency of Natural Resources.

Eurasian watermilfoil is native to much of Europe, Asia, and northern Africa, and competes aggressively to displace and reduce the diversity of native aquatic plants. It elongates from shoots initiated in the fall, beginning spring growth earlier than other aquatic plants. Tolerant of low water temperatures, it quickly grows to the surface, forming dense canopies that overtop and shade the surrounding vegetation. Canopy formation and light reduction are significant factors in the decline of native plant abundance and diversity observed when it invades healthy plant communities.

Eurasian water-milfoil has less value as a food source for waterfowl than the native plants it replaces. And although fish may initially experience a favorable effect, the characteristics of the plants overabundant growth cancel out any short-term benefits it may provide fish in healthy waters. At high densities, its foliage supports a lower abundance and diversity of invertebrates, organisms that serve as fish food. Dense cover allows high survival rates of young fish; however, larger predator fish lose foraging space and are less efficient at obtaining their prey.

The growth and eventual decay of thick vegetation degrades water quality and depletes dissolved oxygen levels. Typical dense beds restrict swimming, fishing, and boating, clog water intakes, and result in decaying mats that foul lakeside beaches.

Zebra Mussels

Zebra mussels are a shellfish that have a striped pattern that differs from most other shellfish, although color patterns can vary to the point of having only a dark or light-colored shell with no stripes. Zebra mussels are stable on their flattened underside and angular in shape. The mussels or freshwater mussels that can attach to objects, which may include rocks, aquatic plants, dock pilings, other shellfish, and any other hard or semi-hard underwater surface[146] This species blocks intake pipes for power generation and water treatment facilities.

Figure 4.6.6: Zebra Mussels. Photo Credit: Vermont Agency of Natural Resources.

[146] Vermont Invasives website. Retrieved at: https://www.vtinvasives.org/invasive/zebra-mussels

The Lake Champlain Basin Program notes that the lake is home to 51 known AIS, with the threat of many more species entering from nearby waterways. In addition, once in the Lake, they can infest inland water bodies, making the prevention of spread critical[147]. Of the total number of invasive species in the Lake, the high management priorities in the management plan include Alewife, Asian Clam, Eurasian Watermilfoil, Japanese Knotweed, Purple Loosestrife, Water Chestnut, and Zebra Mussel.

Location

Due to the differing variety and characteristics of plant and aquatic invasive species, exact locations are difficult to identify. In general, the invasive plant species outlined in this section can impact vulnerable trees anywhere within the planning area. Ash, hemlock, and other hardwoods are susceptible to these species.

As noted above, as of March 2022, infestations of Emerald Ash Borer have been confirmed in the towns of Colchester and Richmond. That being the case, all or at least a portion of each of the 19 jurisdictions within the County is within a 10-mile radius of these two infestations. The Vermont Department of Forest, Parks and Recreation assumes that infestations will continue to spread. They maintain an EAB Infested Area map which is updated whenever a new confirmed infestation is detected.

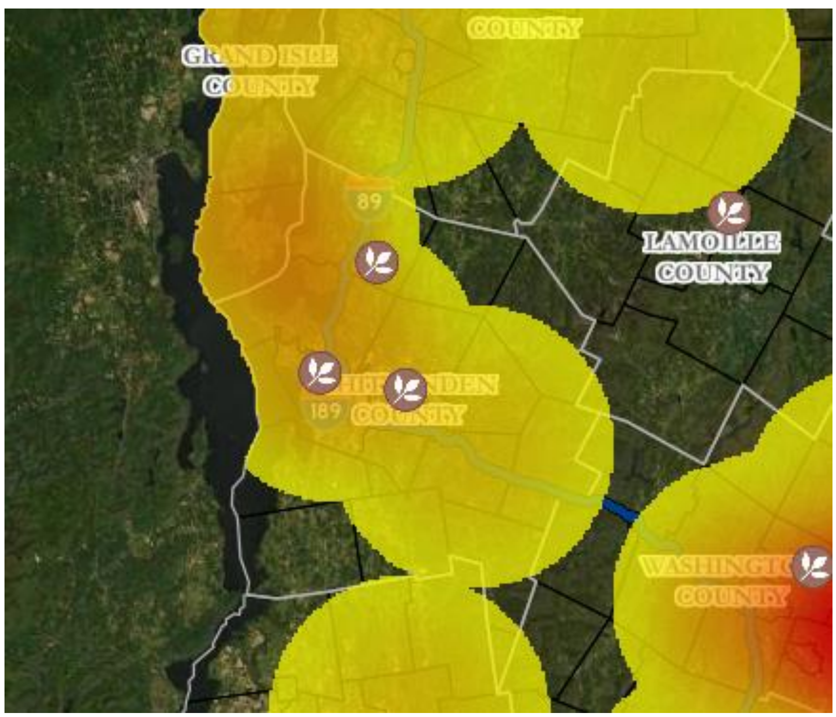


Figure 4.6.7: Emerald Ash Borer Infested Areas, Chittenden County[148]

[147] "Aquatic Invasive Species", Lake Champlain Basin Program website. Retrieved at: https://www.lcbp.org/our-goals/healthy-ecosystems/aquatic-invasive-species/

[148] Vermont Agency of Natural Resources, Emerald Ash Borer Infested Area in Vermont. Map retrieved at: Retrieved at: Emerald Ash Borer (EAB) Infested Area in Vermont (arcgis.com). Yellow indicates EAC has been found, but less severe infestation.

The invasive aquatic species profiled in this section typically occur in Lake Champlain and its connecting waterways.

Extent

Invasive species can be separated from other species by geographical or genetic barriers that prohibit or reduce the chance of spread. Balanced ecosystems usually contain species that are in ideal environmental conditions for growth. When species that are not natural to the local environment are introduced into a different ecosystem, they can result in negative impacts that interfere with the system's natural balance. Pollution, climate change, and population growth are all threats to the changing environment. These threats may lead to species extinction or even destroy the local ecosystem.

Previous Occurrences

Occurrences of plant and animal invasive species are typically monitored or tracked by the appropriate level of government and responsible agency. The Lake Champlain River Basin Program monitors and implements programs to control invasive aquatic species in the Lake and its connecting waterways.

Probability of Future Occurrences

Plant-based and aquatic species can come from any place in the globe due to international travel and consumer shipments. This has frequently allowed species previously unknown in a country or region to take root and flourish because there is no known predator or natural condition in the environment to block growth. In addition, some biological and chemical controls used to limit spread of other invasive species have little or no effect on the new species. In some cases, a species that is introduced for beneficial purposes, such as controlling other invasive species, results in having a negative effect on the ecosystem and is difficult to eradicate. Regulations that prohibit introducing new species into the environment can assist in preventing further invasive plants and animals from impacting another habitat.

Table 4.6.1: Invasive Species Hazard Profile Summary

HUMAN INFECTIOUS DISEASE **Risk Assessment: Medium**	**Location**: All county locations. **Extent**: Dependent on species **Duration**: Weeks to months or years **Probability**: Moderate **Seasonal Pattern**: Varies by species type and host environment. **Speed of Onset**: Weeks to months **Warning Time**: Moderate **Repetitive Loss**: Not applicable	*Potential Cascading Effects* • Threat to plant and animal species • May have public health and safety impact • Environmental impact • Direct and indirect economic loss

4.6.2 Risk Assessment

Invasive species can cause economic, social, environmental, ecological, and human health impacts.

Population

Invasive species can infect humans with new diseases, serve as vectors for existing diseases or cause wounds that exacerbate pre-existing health conditions, such as allergies. Most species that impact public health are pests such as mosquitoes and ticks, that serve as carriers for many diseases including West Nile Virus and Lyme Disease, or the Africanized honey bee, which is a more aggressive bee variety known to attack humans in large swarms over long distances.

Built Environment and Community Lifelines

Built environment impacts are typically minimal, except for species that interact with Community Lifelines, such as the Eurasian Watermilfoil which can clog water intakes supplying drinking water or power generation systems.

Natural Environment

All invasive species have the potential to cause significant impacts to the natural environment. The impacts of the Emerald Ash Borer are already being felt in Chittenden County, and multiple municipalities are developing or implementing tree removal and replacement plans to address this pest.

Economy

Attempts to eliminate or reduce the spread of invasive species often requires significant public and private expenditures for control. In addition, the impact to the fishing industry and loss of agroforestry from infected trees leads to direct economic loss as well as indirect impacts from lost jobs and wages.

Hazard Risk Ranking

Each jurisdiction in the Planning Area conducted a risk analysis to consider impacts, consequences (including magnitude/severity), and probability of future occurrences to determine the Overall Risk Rating for invasive species.

Table 4.6.2: Invasive Species Hazard Risk Rating Summary, All Municipalities

JURISDICTION	Sum - Impact/ Consequence Score	Probability	Total Risk Rating *(Impact/ Consequences x Probability)*	Hazard Ranking
Bolton	5	4	**20**	**Medium**
Buels Gore	5	2	**10**	**Low**
Burlington	5	2	**10**	**Low**
Charlotte	3	2	**6**	**Low**
Colchester	4	5	**20**	**Medium**
Essex	5	4	**20**	**Medium**
Essex Junction	5	4	**20**	**Medium**
Hinesburg	2	2	**4**	**Low**

Huntington	5	5	**25**	**Medium**
Jericho	4	4	**16**	**Low**
Milton	1	5	**5**	**Low**
Richmond	3	4	**12**	**Low**
Shelburne	2	3	**6**	**Low**
South Burlington	5	3	**15**	**Low**
St. George	1	4	**4**	**Low**
Underhill	5	3	**15**	**Low**
Westford	4	4	**16**	**Low**
Williston	3	5	**15**	**Low**
Winooski	0	0	**0**	**Low**
AVERAGE SCORE			**12.6**	**Low**

The compilation of jurisdiction risk scores, along with consideration of the hazard profile and potential impacts and consequences, indicates that **invasive species** is a **low-risk** hazard for fourteen municipalities, and a **medium-risk** hazard for five municipalities within the Planning Area. Consequently, a minimal vulnerability analysis is appropriate to identify potential exposure to the municipalities within the Planning Area. In addition, due to the broad nature of plant and animal invasive species, a detailed vulnerability analysis cannot be presented in this Plan update.

4.6.3 Vulnerability Analysis

Each type and variety of invasive species has its own potential vulnerability. As an example, the Emerald Ash Borer has widely impacted the municipalities in Chittenden County and significant efforts are underway to control and eliminate this pest. The Chittenden County Regional Planning Commission is working with municipalities to inventory the number of ash trees impacted, develop EAB-specific plans, and remove diseased trees to prevent spread. As of September 21, 2021, 13 municipalities have conducted some type of inventory, and eight have adopted an EAB-specific plan. Another three municipalities are in the process of adopting EAB plans. In addition, seven municipalities had already begun tree removal.

Table 4.6.3: Chittenden County Emerald Ash Borer Mitigation Program Status, as of September 21, 2021[149]

Municipality (Date of confirmed EAB infestation)	Has adopted an EAB-specific plan	Has conducted some Emerald Ash Tree inventory	Number of Ash Trees inventoried to date	Has started removing trees
Bolton	N	N	-	N
Buel's Gore	N	N	-	N

[149] Chittenden County Regional Planning Commission, Emerald Ash Borer Program Status, March 30, 2022. For information on preparedness strategies for Emerald Ash Borer in Vermont, visit https://vtcommintyforestry.org/community-planning/tree-pests.

Municipality (Date of confirmed EAB infestation)	Has adopted an EAB-specific plan	Has conducted some Emerald Ash Tree inventory	Number of Ash Trees inventoried to date	Has started removing trees
Burlington	Y	Y	1,275	N
Charlotte	Y	Y	2,180 (State app)	Y
Colchester (6/2021)	In progress	Y	178 (Urban app)	N
Essex	Y	Y	212 (Urban app)	Y
Essex Junction	Y	Y	141 (Urban app)	Y
Hinesburg	N	Y	69 (Urban app)	N
Huntington	Y	Y	2,644 (Arrowwood)	N
Jericho	N	N	-	N
Milton	In progress	Y	1,787 (State app)	N
Richmond (10/2021)	N	Y	912 (State app)	Y
St. George	N	N	-	N
Shelburne	Y	Y	838 (State app)	Y
South Burlington	Y	Y	760 (Urban app)	Y
Underhill	N	N	289 (State app)	N
Westford	N	N	-	N
Williston	Y	Y	938 (State app)	Y
Winooski	In progress	Y	58 (Urban app)	N

Table Notes:
1. (State App = State Roadside Ash Inventory App; cf. https://vtcommunityforestry.org/ash-inventory
2. Urban App = Urban Tree Inventory App (Used for all trees, not just ash). Number shown is for ash. Cf. https://vtcommunityforestry.org/resources/inventories-management-plans
3. Burlington data: 2015, from https://enjoyburlington.com/emerald-ash-borer/
4. Huntington used Arrowwood Environmental to conduct their inventory, cf. this dashboard and report.
5. Data for South Burlington is based upon DEC conversation with City Arborist.
6. Inventory counts were conducted over the past several years. Some municipalities have already started removing inventoried trees.
7. # of ash trees inventoried is for informational purposes only. No inventory targets are set nor implied (e.g., % miles of public roadways). Inventories were and are generally focused on areas within rights-of-way of a limited set of select public properties and public roads. Inventory counts are by no means exhaustive of all such municipally controlled lands.

Lake Champlain's watershed encompasses 8,234 square miles in New York, Vermont and Quebec, Canada. It includes hundreds of lakes and ponds, and 34 major tributaries. Consequently, it plays one of the most significant roles in supporting critical fish, wildlife, water supply, recreation, and power generation for the northeast region of the United States.

The *Lake Champlain Basin Aquatic Nuisance Species Management Plan*, 2005, highlights the importance of early detection and monitoring in order to eliminate or limit invasive species already impacting the Lake, or prevent the introduction of new invasive species. One of the plan's purposes is to abate harmful ecological, socioeconomic, and public health and safety impacts resulting from infestations of aquatic invasive species in the Lake's basin. The plan identifies priority actions to be implemented over time, providing the opportunity for continual review and re-prioritization as new species may appear.

Factors for Consideration in the Next Planning Cycle

Future monitoring, evaluating, and updating of this plan should consider the following factors related to invasive species, as well as other information from the Vermont SHMP updates:

- Have invasive species events occurred within the planning area since adoption of 2022 *MJAHMP*?
- Did invasive species events take place in areas adjacent to the planning area that impacted the planning area by virtue of their being located within proximity?
- Has any new scientific research or methodology changed the ability to predict invasive species impacts or assess risk and vulnerability?
- Has there been significant change in the population, built environment, natural environment, or economy that could affect the risk or vulnerability related to invasive species?
- Is there new evidence related to the impacts of climate change that could affect the level of risk or vulnerability in relation to invasive species?

SECTION 4.7 SEVERE RAINSTORM

(Including Thunderstorm, High Winds, Hail, Lighting, Tornado and Tropical Storm/Hurricane)

2022 HMP Update
The 2022 Plan update continued to incorporate formatting changes and analyses implemented in the 2017 plan. These changes included, but were not limited to: • Re-examining the Severe Rainstorm hazard and performing a new risk assessment and vulnerability analysis. • Refreshing the hazard profiles for hazard characteristics included under this section. • Determining the number of previous hazard events and losses by jurisdiction using NCEI and other data sources, where available. • Updating the assessment of risk by jurisdiction based on new data. • Ranking the hazard by jurisdiction using the methodology described in detail in Section 4, Ranking and Analysis Methodologies. • Reformatting sections for improved clarity and, as available and appropriate, incorporating new maps and imagery.

Severe Rainstorm					Overall Vulnerability
Definition, Key Terms, and Overview[150]					High
Several elements that may accompany Severe Rainstorms are discussed in this section. They are briefly defined here and discussed in detail within this section. **Severe Rainstorm:** A severe storm that produces winds of at least 58 miles per hour, and/or hail of at least 1 inch in diameter, and/or a tornado. They can last for a few minutes to several hours and produce heavy rainfall. **Hail:** Showery precipitation in the form of irregular pellets or balls of ice more than 5 millimeters in diameter, falling from a cumulonimbus cloud. **High Wind:** Strong damaging winds sustained ≥ 40 miles per hour or frequent guests ≥ 58 miles per hour. **Lightning**: A visible electrical discharge produced by a severe rainstorm. The discharge may occur within or between clouds, between the cloud and air, between a cloud and the ground, or between the ground and a cloud. **Tornado**: A violently rotating column of air, usually pendent to a cumulonimbus cloud, with circulation reaching the ground. **Hurricane**: A tropical cyclone that has maximum sustained surface winds of 74 miles per hour or greater. Tropical cyclones include Tropical Storms, with sustained surface winds of 39 miles per hour or greater.					
Frequency	Probability	Potential Magnitude			
		Injuries/Deaths	Infrastructure	Environment	
Medium	**High**	Low	High	Medium	

[150] NOAA, National Weather Service, Hazardous Weather Definitions. Retrieved at: https://www.weather.gov/bgm/severedefinitions

4.7.1 HAZARD PROFILE

Severe rainstorms are described in this section within the context of their hazard characteristics including, Severe Rainstorms; High Winds /Tropical Storms, Lighting, tornado, and Hail.

Severe Rainstorm

According to the National Weather Service (NWS), more than 100,000 severe rainstorms (also known as "thunderstorms") occur each year in the United States, though only about 10 percent of these storms are classified as *severe*. A severe rainstorm with wind gusts in excess of 58 miles per hour (50 knots) and/or hail with a diameter of 1 inch or more is classified as a severe rainstorm, for the purpose of this Plan. Although severe rainstorms generally affect a small area, they are dangerous because of their ability to generate tornados, hail, strong winds, flash flooding, and lightning. While severe rainstorms can occur in all regions of the United States, they are most common in the central and southern states because atmospheric conditions in those areas are ideal for generating and feeding these powerful storms.

Multiple cloud-to-ground and cloud-to-cloud lightning strikes observed during a nighttime severe rainstorm. (Photo courtesy of NOAA Photo Library, NOAA Central Library; OAR/ERL/ National Severe Storms Laboratory)

Severe rainstorms occur when air masses of varying temperatures and moisture content meet. Rapidly rising warm moist air is the driving force for severe rainstorms' creation. These events may occur singularly, in lines, or in clusters. They can move through an area quickly or linger for hours.

Wind is the motion of air past a given point caused by a difference in pressure from one place to another. Wind poses a threat to Chittenden County in many forms, including wind produced by severe rainstorms and tropical weather systems. The effects can include blowing debris; interruptions in electric power, communications, and infrastructure, and other intensified effects of severe storms that occur in combination with severe weather. The hazard may cause harm to people and animals, as well as damage to property and Community Lifelines.

Some storms produce a particular type of high wind called a **derecho**. Derechos are widespread, long-lived, straight-line windstorms associated with severe rainstorms. They can cause hurricane-force winds, tornadoes, heavy rains, and flooding. Derechos travel quickly, with sustained winds that often exceed hurricane-force. They typically occur in the summer months, though they can occur any time of year and ant any time of the day or night.

Lightning, which may accompany severe rainstorms, is a discharge of electrical energy resulting from the buildup of positive and negative charges within a severe rainstorm, creating a bolt when the buildup of charges becomes strong enough. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes, but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder. On average, 89 people are killed each year by lightning strikes in the United States.

A tornado is a violently rotating column of air extending from a rainstorm to the ground. The most violent tornadoes are capable of tremendous destruction with wind speeds capable of reaching in excess of 250 mph. Damage paths can be in excess of a mile wide and 50 miles long. The Enhanced Fujita Scale is a categorical rating system between EF0 and EF5 for wind speed during a tornado.

Tropical storms are formed when tropical depression systems are organized with an “eye” and winds reach at least 39 miles per hour. Hurricane force winds are defined by the National Weather Service as winds that reach a velocity of at least 74 miles per hour. Chittenden County’s impacts from tropical systems could include high wind and heavy rainfall.

Location

Severe rainstorms, and their related characteristics, are possible in any part of Chittenden County.

The National Weather Service (NWS) collected data includes severe rainstorm days, number and duration of thunder events, and lightning strike density for the 30-year period from 1948 to 1977. The analysis of this data determined that on average, 25 to 35 severe rainstorm events occur annually in Chittenden County. Therefore, no one portion of the County is more likely than another to experience severe rainstorm and high wind events.

Extent

Straight-line winds, which in extreme cases may result in wind gusts that exceed 100 miles per hour, are responsible for most rainstorm wind damage. One type of straight- line wind, the downburst, can cause damage equivalent to that of a strong tornado and can be extremely dangerous to the aviation industry.

Force levels six through 12 on the Beaufort Wind Scale describe the extent and related impacts of high winds that affect the natural and built environment.

Table 4.7.1. Beaufort Wind Scale[151]

FORCE	WIND (KNOTS)	WMO* CLASSIFICATION	APPEARANCE OF WIND EFFECTS
0	Less than 1	Calm	Calm, smoke rises vertically
1	1-3	Light Air	Smoke drift indicates wind direction, still wind vanes
2	4-7	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move

[151] NOAA, National Weather Service; World Meteorological Organization.

FORCE	WIND (KNOTS)	WMO* CLASSIFICATION	APPEARANCE OF WIND EFFECTS
3	8-12	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
4	13-18	Moderate Breeze	Dust, leaves, and loose paper lifted; small tree branches move
5	19-24	Fresh Breeze	Small trees in leaf begin to sway
6	25-31	Strong Breeze	Larger tree branches moving, whistling in wires
7	32-38	Near Gale	Whole trees moving, resistance felt walking against wind
8	39-46	Gale	Whole trees in motion, resistance felt walking against wind
9	47-54	Strong Gale	Slight structural damage occurs, slate blows off roofs
10	55-63	Storm	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	64-72	Violent Storm	If experienced on land, widespread damage
12	73+	Hurricane	Violence and destruction

Figure 4.7.1 depicts the number of days per year experiencing winds of > 50 knots. Based on this data, Chittenden County is in a zone that indicates wind of this speed is experienced one to day days per year on average. The Planning Area is noted by the yellow circle.

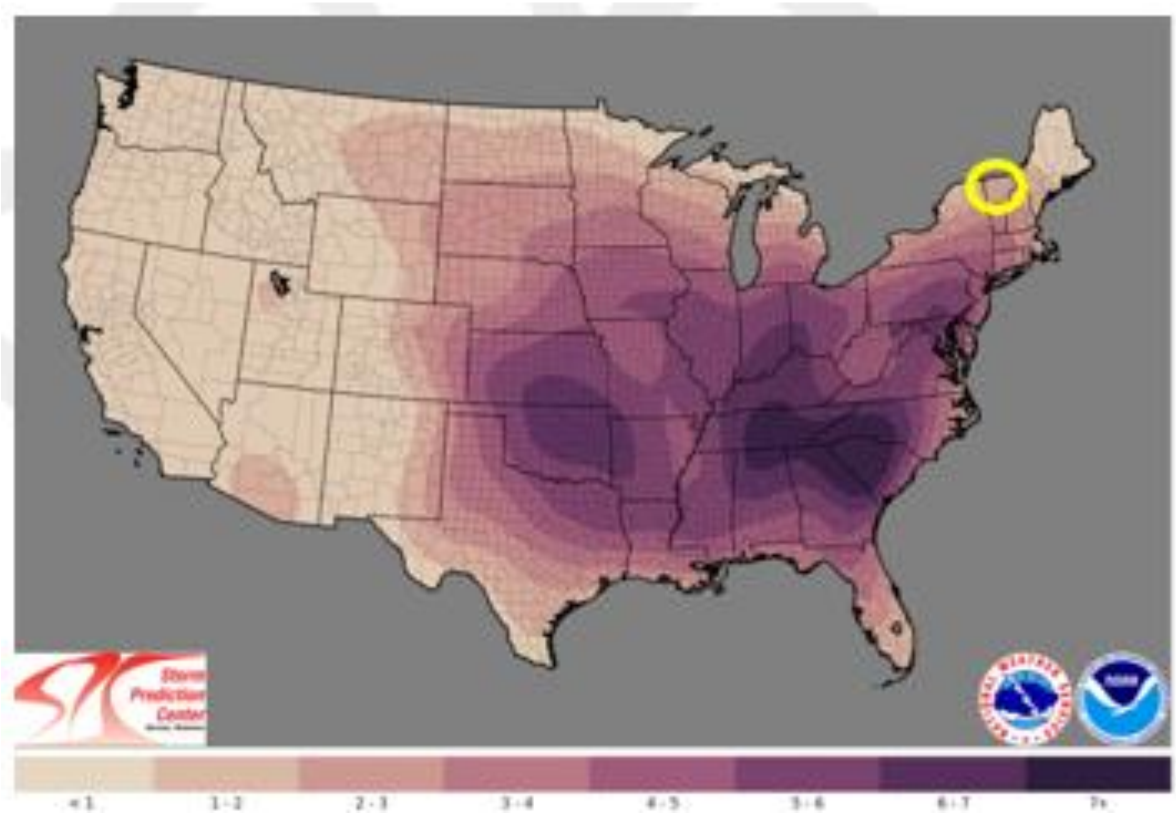


Figure 4.7.1: Mean Number of > 50-Knot Wind Days per Year within 25 Miles of a Point (1986-2015)[152]

Although tornadoes are not a frequent occurrence in Chittenden County, the frequency and strength of extreme windstorms vary across the United States. The map in Figure 4.7.2 was produced by FEMA and is based on 40 years of tornado history and over 100 years of hurricane history. Zone IV, the darkest area on the map, has experienced both the greatest number of tornadoes and the strongest tornadoes. Wind speeds in Zone IV can be as high as 250 MPH. The planning area falls within Zone II, a tornado-susceptible region where winds can reach as high as 160 MPH.

---

152 NOAA, Storm Prediction Center. Retrieved at: https://www.spc.noaa.gov/wcm/climo/allwind.png

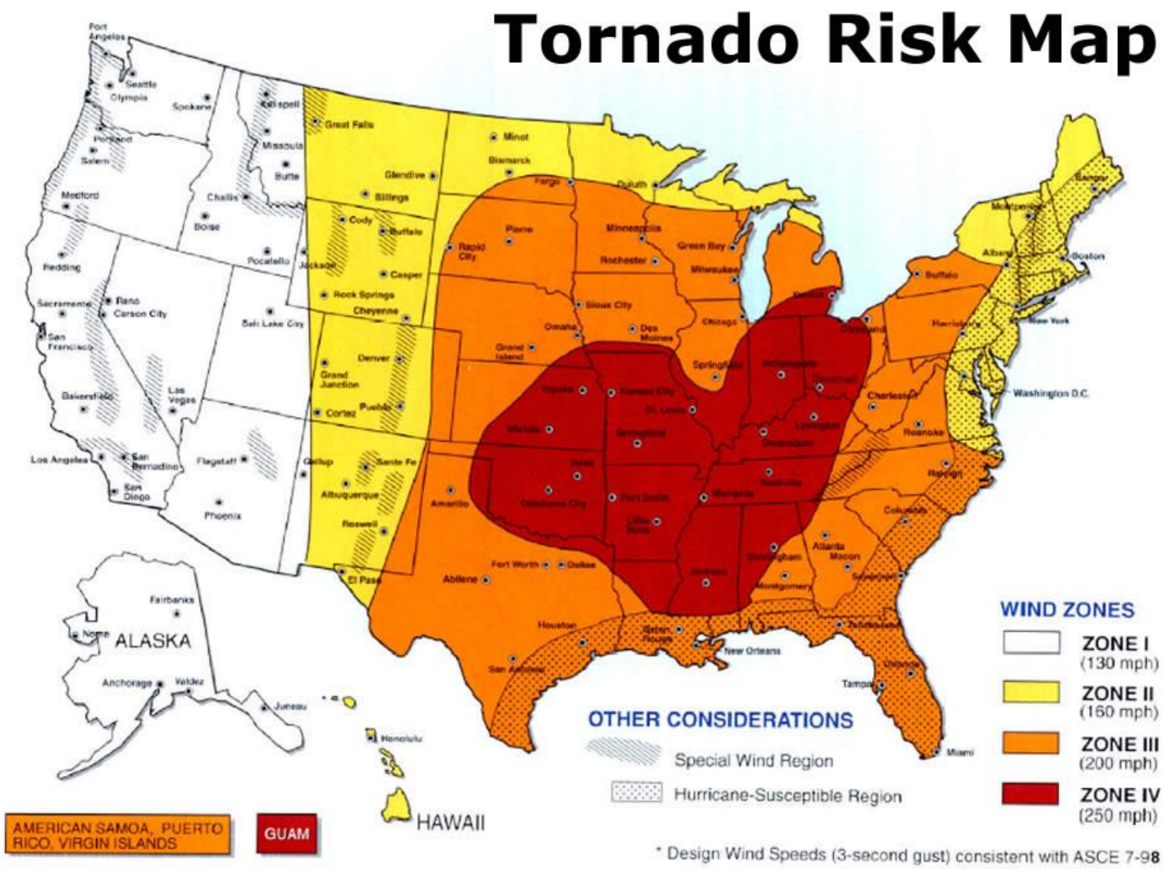


Figure 4.7.2: Tornado Risk Map, United States[153]

Hailstorms are another potentially destructive outgrowth of severe rainstorms. Early in the development of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until, having developed sufficient weight, they fall as precipitation — as balls or irregularly shaped masses of ice greater than 0.75 in. (1.91 cm) in diameter. The size of hailstones is a direct function of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface.

The Hail Intensity and Magnitude Scale describe extent and magnitude of hail storms events which ranges from H0 to H10, with its increments of intensity or damage potential related to hail size (distribution and maximum), texture, fall speed, speed of storm translation, and accompanying wind strength. Based on available data regarding the previous occurrences for the area, the entire planning area may experience hailstorms ranging from an H0 to an H7. Therefore, municipalities can mitigate against a storm from low risk or hard hail to a severe, destructive

[153] Federal Emergency Management Agency

hailstorm with golf ball size hail that leads to severe roof damage and risk of serious injuries.

Table 4.7.2. Hail Intensity and Magnitude Scale[154]

SIZE CODE	INTENSITY CATEGORY	SIZE (Diameter Inches)	DESCRIPTIVE TERM	TYPICAL DAMAGE
H0	Hard Hail	Up to 0.33	Pea	No damage
H1	Potentially Damaging	0.33 – 0.60	Marble	Slight damage to plants and crops
H2	Potentially Damaging	0.60 – 0.80	Dime	Significant damage to plants and crops
H3	Severe	0.80 – 1.20	Nickel	Severe damage to plants and crops
H4	Severe	1.2 – 1.6	Quarter	Widespread glass and auto damage
H5	Destructive	1.6 – 2.0	Half Dollar	Widespread destruction of glass, roofs, and risk of injuries
H6	Destructive	2.0 – 2.4	Ping Pong Ball	Aircraft bodywork dented and brick walls pitted
H7	Very Destructive	2.4 – 3.0	Golf Ball	Severe roof damage and risk of serious injuries
H8	Very Destructive	3.0 – 3.5	Hen Egg	Severe damage to all structures
H9	Super Hailstorms	3.5 – 4.0	Tennis Ball	Extensive structural damage, could cause fatal injuries
H10	Super Hailstorms	4.0 +	Baseball	Extensive structural damage, could cause fatal injuries

Table 4.7.3. Enhanced Fujita Scale[155]

Scale	Wind Speed		Types of Damages Due to Hurricane Winds
	mph	km/h	
EF-0	65-85	105-137	Minor or no damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.
EF-1	86-110	138-177	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF-2	111-135	178-217	**Considerable damage**. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.

[154] NCEI Intensity Scale, based on the TORRO Hailstorm Intensity Scale
[155] NOAA, Storm Prediction Center. Retrieved at: http://www.spc.noaa.gov/efscale/ef-scale.html

Scale	Wind Speed		Types of Damages Due to Hurricane Winds
	mph	km/h	
EF-3	136-165	218-266	**Severe damage**. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations are badly damaged.
EF-4	166-200	267-322	**Devastating damage**. Well-constructed and whole frame houses completely leveled; cars and other large objects thrown, and small missiles generated.
EF-5	>200	>322	**Extreme damage**. Strong-framed, well-built houses leveled off foundations are swept away; steel reinforced concrete structures are critically damaged; tall buildings collapse or have severe structural deformations; some cars, trucks, and train cars can be thrown approximately 1 mile (1.6 km).

Previous Occurrences

Severe rainstorms and winds are a relatively common occurrence across Chittenden County and have been known to occur in all calendar months.

The NCEI documents severe storm events for Chittenden County in its Storm Events Database. The following hazards were used in the NCEI search criteria: hail, heavy rain, high wind, hurricane, lightning, strong wind, thunderstorm wind, tornado, tropical depression, and tropical storm. Events range widely in terms of location, magnitude, and impact. Where possible, NCEI tracks reports separately by zone and, when data is available, impacted jurisdiction although it is not always possible to track damages below a county or city level.

The Storm Events Database documents 736 severe rainstorm, high wind, lightning, hail, tornado, and tropical storm events in Chittenden County between 1950 and May 31, 2021, totaling approximately $53,039,000 in property and crop damages, four injuries and three deaths. Between January 2017 and May 31, 2021, sixty individual severe wind event reports are documented in the county, covering 25 event days.

Table 4.7.4. Total Impact of Severe Rainstorm-Related Hazards in Chittenden County, 1950 to June 2021[156]

Severe Rainstorm					
Location	Number of Events	Direct Deaths/ Injuries	Property Damage ($)	Crop Damage ($)	Total Property and Crop Damage ($)
Chittenden County	7	0	$50,000	0	$50,000
Burlington	2	0	$50,000	0	$50,000
TOTAL	9	0	$100,000	0	$100,000

[156] National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database for "Heavy Rain", January 1, 1950 to June 30, 2021. *Damage costs presented in year of occurrence values, as reported by the NCEI.*

Table 4.7.5. Total Impact of High Winds-Related Hazards in Chittenden County, 1950 to June 2021[157]

HIGH WINDS					
Location	**Number of Events**	**Direct Deaths/Injuries**	**Property Damage ($)**	**Crop Damage ($)**	**Total Property and Crop Damage ($)**
Chittenden Zone	74	5	788,000	0	788,000
Eastern Chittenden Zone	56	0	2,497,000	0	2,497,000
Western Chittenden Zone	44	0	1,888,000	0	1,888,000
Bolton	7	0	55,000	0	55,000
Buels Gore	0	0	0	0	0
Burlignton	26	0	989,000	0	989,000
Charlotte	10	0	175,000	0	175,000
Colchester	20	0	265,000	0	265,000
Essex	16	0	370,000	0	370,000
Essex Junction	12	0	89,000	0	89,000
Hinesburg	12	0	121,000	0	121,000
Huntington	4	0	35,000	0	35,000
Jericho	9	0	191,000	0	191,000
Milton	21	0	286,000	0	286,000
Richmond	11	0	171,000	0	171,000
St. George	0	0	0	0	0
Shelburne	15	0	315,000	0	315,000
South Burlington	8	0	140,000	0	140,000
Underhill	11	0	80,000	0	80,000
Westford	6	0	130,000	0	130,000
Williston	16	0	186,000	0	186,000
Winooski	6	0	79,000	0	79,000
TOTAL	**384**	**5**	**$8,850,000**	**0**	**$8,850,000**

[157] National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database for "High Wind, Strong Wind, Thunderstorm Wind, Tropical Depression, and Tropical Storm", January 1, 1950 to June 30, 2021. Damage costs presented in year of occurrence values, as reported by the NCEI.

Table 4.7.6. Total Impact of Lightning-Related Hazards in Chittenden County, 1950 to June 2021[158]

LIGHTNING					
Location	**# of Events**	**Direct Deaths/Injuries**	**Property Damage ($)**	**Crop Damage ($)**	**Total Property and Crop Damage ($)**
Chittenden Zone	2	0	5,000	0	5,000
Eastern Chittenden Zone	0	0	0	0	0
Western Chittenden Zone	0	0	0	0	0
Bolton	0	0	0	0	0
Buels Gore	0	0	0	0	0
Burlington	2	0	65,000	0	65,000
Charlotte	1	0	200,000	0	200,000
Colchester	4	1	85,000	0	85,000
Essex	0	0	0	0	0
Essex Junction	2	0	1,002,000	0	1,002,000
Hinesburg	0	0	0	0	0
Huntington	0	0	0	0	0
Jericho	1	0	5,000	0	5,000
Milton	1	0	5,000	0	5,000
Richmond	0	0	0	0	0
St. George	0	0	0	0	0
Shelburne	2	0	110,000	0	110,000
South Burlington	2	0	20,000	0	20,000
Underhill	0	0	0	0	0
Westford	2	0	60,000	0	60,000
Williston	2	0	80,000	0	80,000
Winooski	0	0	0	0	0
TOTAL	**21**	**0**	**$1,637,000**	**$0**	**$1,637,000**

Table 4.7.7. Total Impact of Hail-Related Hazards in Chittenden County, 1950 to June 2021[159]

[158] National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database for "Lightning", January 1, 1950, to June 30, 2021. Damage costs presented in year of occurrence values, as reported by the NCEI.

[159] Source: National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database for "Hail", January 1, 1950, to June 30, 2021. Damage costs presented in year of occurrence values, as reported by the NCEI.

Hail					
Location	# of Events	Direct Deaths/Injuries	Property Damage ($)	Crop Damage ($)	Total Property and Crop Damage ($)
Chittenden Zone	32	0	5,000	0	5,000
Eastern Chittenden Zone	0	0	0	0	0
Western Chittenden Zone	0	0	0	0	0
Bolton	3	0	0	0	0
Buels Gore	0	0	0	0	0
Burlington	10	0	0	0	0
Charlotte	5	0	11,000	0	11,000
Colchester	12	0	0	25,000	25,000
Essex	3	0	0	50,000	50,000
Essex Junction	3	0	0	0	0
Hinesburg	6	0	0	0	0
Huntington	1	0	0	0	0
Jericho	2	0	0	0	0
Milton	9	0	20,000	20,000	40,000
Richmond	3	0	0	0	0
St. George	0	0	0	0	0
Shelburne	3	0	0	0	0
South Burlington	5	0	0	0	0
Underhill	10	0	0	0	0
Westford	8	0	70,000	70,000	140,000
Williston	9	0	0	0	0
Winooski	6	0	0	0	0
TOTAL	130	0	$106,000	$165,000	$276,000

Severe Rainstorm: The NCEI Storm Events Database[160] recorded a total of nine Severe Rainstorm events with no deaths or injuries reported during the period from January 1950 through June 2021, resulting in $100,000 million dollars in property damages. These events have occurred throughout the planning area (i.e., the county) and have not been mapped as discrete events.

High Wind: The NCEI Storm Events Database recorded a total of 384 High Wind events with two deaths near Champlain Airport on July 30, 2019, and three injuries near Mt. Philo on August 24, 2019 during the period from January 1950 through June 2021. The total property damage for Chittenden County in those 71 years is $8.850 million. These events have occurred throughout the planning area (i.e., the county) and have not been mapped as discrete events.

Lightning: The NCEI Storm Events Database has recorded a total of 21 lightning events and no associated deaths and one injury in Chittenden County during the period from January 1950 through June 2021; however, these 21 recorded events all happened after 1996. Recorded lightning events occurred in every year from 1996 through 2020, except for 2000, 2001, 2004, 2008, 2013, 2014, 2015, 2017 and 2019. All recorded lightning events occurred from May through September plus the month of November. All but two events caused at least $1,000 in property damage, and four events caused an estimated $50,000 in damages. The two highest damages were $200,000 and $1,000,000. Both involved a lightning-caused fire that leveled a structure. Cumulative property damages for the 21 events noted was $1,637,000. This data may be incomplete - fire department officials have indicated that lightning has caused many more fires than are recorded in the NCEI database. Local officials also note that a single storm could result in multiple lightning strikes and subsequent fires. Another possible problem associated with lightning is the impact on communications, especially communications between emergency responders, from lightning striking communications infrastructure. These lightning events have occurred all over the planning area (i.e., the county) and have not been mapped as discrete events.

Hail: The NCEI Storm Events Database recorded a total of 130 hail events in Chittenden County during the period from January 1950 through June 2021. Hail events typically occurred from May through September, but most occurred in summer storms from June through August. Total property damage for Chittenden County in those 71 years is $106,000 and the total crop damage is $165,000. Hailstorms can have devastating effects on local farmers though rarely do in Vermont. These hail events have occurred throughout the planning area (i.e., the county) and have not been mapped as discrete events.

Of the 130 reported events, 4 were Ping Pong Ball size (1957, 1968, 2009 and 2009), 13 were Quarter size and 6 were half Dollar size. Data was not available for the 1957 and 1968 events.

---

[160] Severe Rainstorm data was based on the NCEI Heavy Rain category. In addition to these events, data has been reported for other elements of severe thunderstorms that potentially included severe rainfall but are reflected in the data for related event types.

- **On July 16, 2009:** On July 16th, a strong upper atmospheric area of low pressure was located north of the Great Lakes in south central Canada. In addition, a significant mid-level shortwave and associated surface low moved across the eastern Great Lakes, while a warm front and subsequent cold front swept across northern New York and Vermont during the afternoon and evening. Numerous thunderstorms developed and moved across Vermont, in a moderate to strong unstable atmosphere during the afternoon and evening. In addition, there were a few super-cell thunderstorms that produced very large hail, up to 3.3 inches in diameter in Westford (Chittenden county) with numerous reports of damage to vehicles, homes, crop and livestock and a brief EF-0 tornado along the Williamstown-Chelsea town line (Orange county). The measured 3.3-inch diameter hail in Westford, also had a circumference of 6.8 inches and has been determined by the State Climate Extremes Committee as the largest recorded hail stone in Vermont. Several golf ball and larger hail, including a hail stone that measured 3.25 inches in diameter measured by NWS employee. Large hail with reported damage to vehicles, lawn furniture, siding, windows, gardens and crops throughout the Westford vicinity, including local farms, landscaping businesses and apple orchard.

Since the last plan update, 3 events were reported (one in Shelburne and Williston each on May 4, 2018) and one in Williston on July 8,2020.

- **May 4, 2018:** An energetic storm system moved from the Great Lakes across the St. Lawrence Valley into Ontario/Quebec during the afternoon and evening hours of May 4th. Instability was marginal for thunderstorm development during the evening hours with thunderstorms ahead of a cold front. However, winds were unseasonably strong in the atmosphere, accounting for some thunderstorms to produce damaging winds and there was some localized damage in non-thunderstorm winds accompanying the arrival of colder air. Very brief heavy rainfall of up to 2 inches in less than an hour accounted for localized flash flooding and a mudslide. Strong winds and a lake level at/above flood stage caused for 4-to-6-foot waves to batter a causeway between Colchester and Grand Isle on Lake Champlain, resulting in numerous washouts and a closure of the causeway. Estimated quarter and dollar size hail or larger reported.
- **July 8, 2020:** A mid-level shortwave (disturbance) moved from southern Quebec into a unstable air mass across Vermont during the afternoon of July 8th. This lead to several rounds of thunderstorms, some with damaging winds, large hail and torrential rains of 2 to 3+ inches. Nickel size hail was reported.

Tornadoes: The NCEI Storm Events Database has recorded a total of five tornadoes in Chittenden County during the period from 1950 through 2021. A sixth tornado event on June 11, 1973, was also noted by The Tornado Project. Tornado damage tends to be localized. The strongest recorded tornado touched down in Colchester on August 8, 1983. Property damage has totaled over $2.528 million overall in the County due to tornado damage. There have been no deaths or injuries reported as a result of a tornado in the County since 1950. Tornadoes typically occur in Vermont between March and August; however, tornadoes can strike at any time of the year if the essential conditions are present[161].

.

Table 4.7.8. Total Recorded Tornadoes in Chittenden County, 1950-2021[162]

Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
6/21/1953	16.00	F1	0	0	$2,5000	0
6/22/1973	20 :00	F1	0	0	0	0
8/08/1983	14:00	F2	0	0	$2,500,000	0
8/07/1986	16:40	F0	0	0	$500	0
5/31/1987	12:00	F0	0	0	$25,000	0
TOTALS			0	0	$2,528,000	0

While several named tropical storms have affected Vermont, such as Henri in 2021 (which resulted in a Federal Disaster Declaration), Irene in 2011 and Floyd in 1999, the NCEI database reports the tropical systems that impact Chittenden County under different categories such as “high wind” and “flooding” due to the technical definition of the impacts from this type of system. As an example, Tropical Storm Irene in August 2011 is documented in the NCEI database under “high winds” reaching 85 miles per hour at the summit of Mount Mansfield in Lamoille County. The storm caused widespread power outage and heavy rainfall resulting in devastating flooding in central and southern Vermont. The NCEI database notes losses of 2,400 roads, 800 homes/businesses, 300 bridges and a half dozen railroad tracks destroyed or damaged from the flooding caused by Irene. Impacts from Tropical Storm Henri are not currently reported in the NCEI due to a time lag in updating the database.

Table 4.7.9. Recorded Hurricane-Force Winds in Chittenden County, 1950 -2014[163]

Event	Date	Time	Wind Speed	Property Damage
Hurricane-force winds	01/27/1996	0900	95.53 mph	$220,000
Hurricane-force winds	01/04/2000	0330	81.72 mph	$10,000
Hurricane-force winds	8/1/2005	1650	80.6 mph	$100,000
Hurricane-force winds	6/10/2008	1900	80.6 mph	$20,000
Hurricane-force winds	12/9/2009	1400	**87.45 mph**	**$20,000**
TOTAL				$370,000

[161] NOAA, National Centers for Environmental Information, Storm Events Database. Retrieved at: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=50%2CVERMONT

[162] NOAA, National Centers for Environmental Information, Storm Events Database. Retrieved at: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=50%2CVERMONT

[163] NOAA, National Centers for Environmental Information, Storm Events Database. Retrieved at: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=50%2CVERMONT

Federal Disaster Declarations in Chittenden County

Between 1964 and 2021, 24 severe rainstorm events in Chittenden County have been significant enough to be included in multiple Federal Disaster Declarations. Information related to the FEMA-obligated funding under the Public Assistance (PA) program for federally declared disasters is unavailable prior to 2001, as well as the most recent event in September 2021.

Table 4.7.10. Severe Rainstorm and High Winds Disaster Declarations in Chittenden County, 1964 - 2021[164]

Disaster Number	Event Type Individual Assistance (IA) Public Assistance (PA)	Declaration Date	Damage Amount
DR-4621-VT	**Vermont – Severe Storm and Flooding**	09/29/21	[Not available]
DR-4474-VT	**Vermont Severe Storm and Flooding**	01/17/20	Public Assistance- (Cat. A-B) $489,818.42 Public Assistance- (Cat. C-G) $9,076,754.59 HMGP- $18,808.87
DR-3567-VT	**Vermont-Tropical Storm Henri**	08/22/21	[Not Available]
DR-4380	**Vermont Severe Storm and Flooding**	07/30/2018	Public Assistance- (Cat. A-B) $97,652.86 Public Assistance- (Cat. C-G) $2,794,971.46 HMGP- $169,020.79
DR-4356-VT	**Vermont Severe Storm and Flooding**	01/2/2018	Public Assistance- (Cat. A-B) $1,035,633.62 Public Assistance- (Cat. C-G) $3,671,058.70
DR-4232-VT	**Vermont Severe Storm and Flooding**	07/29/2015	Public Assistance Total- $1,226,279.93
DR-4140-VT	**Vermont Severe Storms and Flooding**	08/02/2013	FEMA Obligated Dollars as of 08/24/2021 PA-$6,296,981.81

[164] Federal Emergency Management Agency (FEMA)

Disaster Number	Event Type Individual Assistance (IA) Public Assistance (PA)	Declaration Date	Damage Amount
DR-4120-VT	**Vermont Severe Storms and Flooding (3 counties)**	06/13/2013	FEMA Obligated Dollars as of 03/20/2020 PA-$1,914,682.79
DR-4022-VT	**Vermont Tropical Storm Irene**	09/1/2011	Individual Assistance Total-$23,253,145.17 Public Assistance Total-$208,874,407.61
DR-1995-VT	**Vermont Severe Storms and Flooding**	06/15/2011	Individual Assistance Total-$1,805,969.74 Public Assistance Total-$13,353,019.85
EM-3338-VT	**Vermont Hurricane Irene**	08/29/2011	[Not Available]
DR-1951-VT	**Vermont Severe Storm**	12/22/2010	Public Assistance- (Cat. A-B)-$1,127,995.20 Public Assistance- (Cat. C-G)-$1,555,019.55
DR-1559-VT	**Vermont Severe Storms and Flooding (7 counties)**	09/23/2004	FEMA Obligated Dollars as of 03/20/2020 PA-$2,348,737.81
EM-3167[165]	**Vermont Snowstorm**	04/10/2001	FEMA Obligated Dollars as of 03/20/2020 PA (Cat. B) - $1,296,992.34
DR-1228-VT	**Vermont Severe Storms and Flooding**	06/30/1998	[Not Available]
DR-1201-VT	**Vermont Severe Ice Storms, Rain, High Winds and Flooding (6 counties)**	01/15/1998	[Not Available]
DR-4140-VT	**Vermont Severe Storms and Flooding**	08/2/2013	Public Assistance- (Cat. A-B) $141,750.15 Public Assistance- (Cat. C-G) $5,974,924.66

Disaster Number	Event Type Individual Assistance (IA) Public Assistance (PA)	Declaration Date	Damage Amount
DR-4120-VT	**Vermont Severe Storms and Flooding**	06/13/2013	Public Assistance- (Cat. A-B) $156,257.50 Public Assistance- (Cat. C-G) $1,714,406.99
DR-1063-VT	**Vermont Heavy Rain, Flooding (6 counties)**	04/16/1995	[Not Available]
DR-990-VT	**Vermont Flooding, Heavy Rain, Snowmelt (4 counties)**	05/12/1993	[Not Available]
DR-938-VT	**Vermont Flooding, Heavy Rain, Ice Jams**	03/18/1992	[Not Available]
DR-875-VT	**Vermont Flooding, Severe Storm**	07/25/1990	[Not Available]
DR-518-VT	**Vermont Severe Storms, High Winds, Flooding**	08/05/1976	[Not Available]
DR-397-VT	**Vermont Severe Storms, Flooding, Landslides**	07/06/1973	[Not Available]

Probability of Future Occurrence

Since severe storms are difficult to predict, it is extremely challenging to determine probability of future occurrence with any degree of accuracy. It can, however, with considerable confidence based on historical record, be projected that Chittenden County will continue to experience severe rainstorms with great frequency – several times a year, in most cases. Based on analysis of previous events in the NCEI database, severe rainstorms have a return interval of approximately 0.13 percent in any given year[166]. In addition, it appears that those events causing injury, death or damage have occurred on a seemingly random basis with no portion of Chittenden County more likely to experience them than any other.

The **National Risk Index (NRI)** also provides an annualized frequency value for multiple natural hazards, including the hazard elements of Severe Rainstorm - hail, lightning, hurricane/tropical storm, strong wind, and tornado.

The NRI method of calculating probability determines the return rate based on previous occurrences. The recurrence interval of the multiple elements of Severe Rainstorms is defined as the average time interval, in years, expected between an event of a particular magnitude and an equal or larger event. Magnitude increases with increasing recurrence intervals. Using this

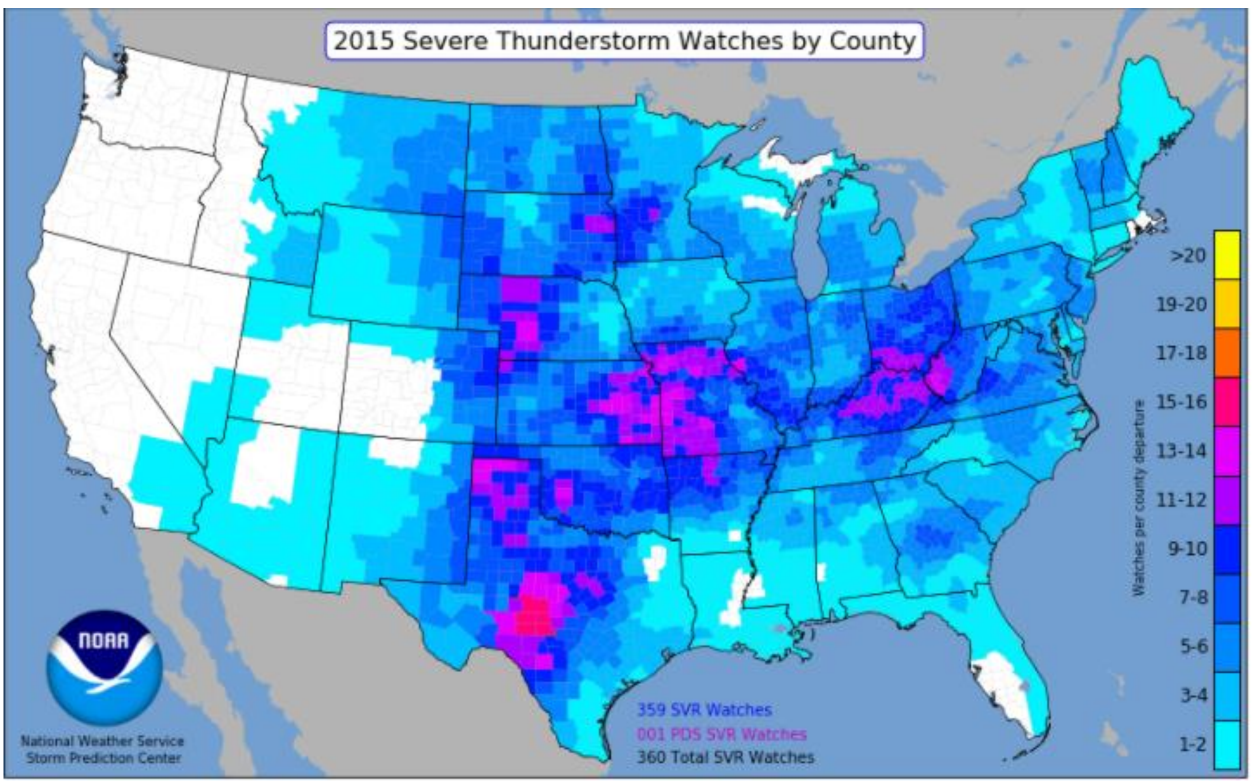
[166] Return interval calculated by dividing the number of years of record (70.5) by the number of hazard events (543).

method, the number of years of record (70.5) was divided by the number of occurrences in Chittenden County, resulting in a simple past-determined recurrence interval.

Table 4.7.11: NRI Annualized Frequency Value for Hazard Event Types Related to Severe Rainstorm (Number of Events per Year)[167]

Hail	Lightning	Hurricane	Strong Wind	Tornado
1.3	19.9	0	0.8	0

Another method of calculating the frequency of Severe Rainstorms is assessing the number of severe thunderstorm watches issued by the National Weather Service in a specific year. This method is less exact as it does not address the variables in climate changes through multiple years but provides a somewhat reliable guide for planning purposes. The graphic in Figure 4.7.3 indicates that Chittenden County had from three to six watches in 2015, the most recent year for which map data is available.



[167] National Risk Index Community Report for Chittenden County, Vermont, dated May 2, 2022. Retrieved at: https://hazards.fema.gov/nri/report/viewer?dataLOD=Counties&dataIDs=C50007

Figure 4.7.3: 2015 Severe Thunderstorm Watches by County[168]

Climate change is another variable in predicting future occurrences, in that it is projected to increase the frequency and intensity of extreme weather events, including severe rainstorms. Using global climate models and a high-resolution regional climate model, one study that investigated the link between severe rainstorms and global warming found a net increase in the number of days with environmental conditions that foster the development of severe rainstorms. This was true for much of the United States, including Chittenden County.

Table 4.7.12: Risk Assessment

Severe Rainstorm Risk Assessment: High	**Location**	Jurisdiction-wide	***Potential Cascading Effects***
	Extent	Life safety threat; mild to severe damage to property, turf, wildlife, urban forest	• Life safety impact on healthcare system • Power/utility outages • Traffic/roadway damage or closures • Responder safety • Increased security • Direct and indirect economic impact • Loss of Revenue
	Duration	Several minutes to several hours	
	Probability	High	
	Seasonal Pattern	Year-round	
	Speed of Onset	Slow to Rapid	
	Warning Time	Hours to days	
	Repetitive Loss	N/A	

4.7.2 RISK ASSESSMENT

The level or risk related to severe rainstorms depends on the assets affected when an event strikes the planning area, as well as the strength of the storm that precipitates the rain and related conditions. These events may cause damage as slight as toppling patio chairs, moderate damage in the form of uprooting large trees or removing structural roofing, or as severe as widespread flooding and fluvial erosion.

Risk, defined as probability multiplied by impact, cannot be fully estimated for damaging severe rainstorms and high wind, hail, and lightning events due to the lack of intensity-damage models for these hazards. Instead, financial impacts of damaging rainstorm events are illustrated using data included from the NCEI Storm Events Database. While multiple communities often submit reports for the same incident, each report describes how the event affected their jurisdiction. During the cited period, there were two deaths and three injuries directly related to severe rainstorm and high wind events, however, the entire population across Chittenden County is at risk. Given the countywide reported total of **$10,863,000** for property and crop damages indicates that people, structures, and agricultural assets are at risk to severe rainstorms and high

[168] NOAA, National Weather Service, Storm Prediction Center. Retrieved at: https://www.spc.noaa.gov/wcm/2015-wbc-anoms.png

wind.

People

The severity of a severe rainstorms and high wind events on a community can be magnified to the degree they affect vulnerable populations. Those that may require special assistance during such events may not be able to protect themselves prior to an event or may not be able to understand potential risks. These can include very young and elderly populations, those without transportation resources, or those in a lower socioeconomic group. Tourists and visitors to the area also have increased risk, as they are less familiar with the geography of the area and the typical means of warning residents regarding dangerous conditions. Additionally, persons living in communities along Lake Champlain are particularly at risk to winds and storms approaching from over the waterway.

Built Environment

Community Lifelines

Quantitative assessment of critical facilities for severe rainstorm and high wind risk was not feasible for this update because such events are not geographically specific and are likely to affect the entire planning area. What is known is that age of construction plays a role in vulnerability of facilities to severe rainstorm.

It is important to note that not all critical facilities have redundant power sources, and structures may not be wired to allow the addition of an emergency backup generator for residential or commercial use. Future Plan updates should consider including a more comprehensive examination of critical facility vulnerability to severe rainstorm, and it is determined to be a high mitigation priority, included in the mitigation strategy actions to upgrade generator capacity at essential facilities.

Nonetheless, maintaining continuity of operations of transportation, infrastructure, utilities, and government assets is critical to minimizing health and safety issues for the public, and economic damage that may result from businesses being unable to move equipment or product.

Existing Buildings and Infrastructure Risk

Risk to existing buildings and infrastructure is largely determined by building construction type. Concrete, brick, and steel-framed structures tend to fare better in severe rainstorm and high wind events than older, wood-framed structures. Manufactured homes and residential buildings constructed in earlier decades and designed to meet less stringent building codes for the time period. There may have been a lower degree of code enforcement at the time of construction. If not well-maintained, such buildings may have deteriorated over the years. Electric outages are caused by falling limbs, trees, and poles, by power lines snapping together; and by flying debris, all of which affects the built environment.

Natural Environment and Economy

Communities within the planning region area include natural assets vulnerable to severe rainstorm and high wind. winds may topple trees, streetlights, and power poles and damage fabric shelters set up in the area's federal, state, and local parks. The region is a tourist magnet for special events held outdoors, so severe rainstorm may cause damage to temporary tents and stages erected to accommodate such festivities.

Changes in Development

As was discussed above, the planning area's vulnerability to severe rainstorm has remained constant overall. No new development has taken place, nor have older structures been removed, which would increase or decrease the probability of this hazard in the remote areas. This validates what was previously identified in the 2017 *MJAHMP*.

Potential Impacts of Climate Change

As the climate continues to change, the severity of storms may increase, producing more severe rainstorm and high wind events. This in turn may require more firefighting resources and hardening of vulnerable infrastructure such as power poles and utility lines

Hazard Risk Ranking

Each jurisdiction in the Planning Area conducted a risk analysis to consider impacts, consequences (including magnitude/severity), and probability of future occurrences to determine the Overall Risk Rating for severe rainstorm.

Table 4.7.13: Severe Rainstorm/High Winds Hazard Risk Rating Summary, All Municipalities

JURISDICTION	Sum - Impact/ Consequence Score	Probability	Total Risk Rating *(Impact/ Consequences x Probability)*	Hazard Ranking
Bolton	10	5	50	High
Buels Gore	6	4	24	Medium
Burlington	6	4	24	Medium
Charlotte	7	5	35	Medium
Colchester				
Essex	5	4	20	Medium
Essex Junction	5	4	20	Medium
Hinesburg	8	5	40	High
Huntington	7	5	35	Medium

Jericho	6	5	30	Medium
Milton	8	5	40	High
Richmond	4	4	16	Low
Shelburne	9	5	45	High
South Burlington	8	5	40	High
St. George	11	4	44	High
Underhill	9	5	45	High
Westford	6	5	30	Medium
Williston	8	5	40	High
Winooski	8	5	40	High
AVERAGE SCORE			33.6	Medium-High

The compilation of jurisdiction risk scores, along with consideration of the hazard profile and potential impacts and consequences, indicates that **severe rainstorm** is a **high-risk** hazard for nine municipalities, and a **medium-risk** hazard for eight municipalities within the Planning Area. Consequently, the hazard ranking average is **medium-high,** and a vulnerability assessment is appropriate to identify the level of exposure to the municipalities within the Planning Area.

4.7.3 VULNERABILITY ANALYSIS

Chittenden County municipalities face uniform susceptibility to the effects of severe rainstorms. As is the case with risk from hurricane and tropical storm force-winds, the most at-risk buildings to rainstorm are assumed to include manufactured homes and older residential structures. Another great concern for Chittenden County, regarding severe rainstorms, is damage to electric power lines which regularly cause power outages for residents and businesses across the area, and have disrupted the availability of emergency services, including 911. During past events, storm winds have downed trees across power lines, snapped utility poles and even blown down transformers resulting in widespread outages. Downed power lines create a dangerous threat to public safety; while difficult to quantify, long-term power outages can result in significant hardship for residents and major economic impacts for local businesses.

Hail, while not a major threat to human safety, can be extremely destructive to crops and personal property (particularly vehicles, as well as roofs, siding, and windows of buildings). Most hail damage recorded for Chittenden County has been in Colchester, Shelburne, and Williston, though all areas are equally at risk.

General Exposure

Because severe storms are not geo-specific, the entire planning area population is exposed to such hazard events. The Hazus-generated table below for the flood hazard, and again presented under the discussion of Hurricanes, identifies the exposure of structures in the planning region that are also at risk to severe storms

Table 4.7.14. Chittenden County - Total building exposure by occupancy type[169]

Occupancy	Exposure ($1000)	Percent of Total
Residential	$14,866,050	73.10%
Commercial	$3,687,915	18.13%
Industrial	$865,812	4.26%
Agricultural	$65,133	0.32%
Religious	$242,454	1.20%
Government	$200,006	0.98%
Education	$408,670	2.01%
Total	$20,336,040	100.00%

Historical

Previous events illustrate how severe rainstorms have affected the overall planning area.

National Risk Index (NRI)

Lacking specific municipal-level data for determining exposure values, the NRI assessment includes an Expected Annual Loss (EAL) calculation which quantifies loss for relevant consequence types (buildings, people and agriculture) for multiple hazards including hail, lightning, hurricane, strong wind and tornado. The EAL is calculated using a multiplicative equation that includes exposure, annualized frequency, and historic loss ratio risk factors.[170]

Table 4.7.15: Expected Annual Loss Values for Severe Rainstorm (hail, lightning, hurricane, strong wind and tornado), Chittenden County[171]

Hazard Type	Building Value	Population Equivalence[172]	Population	Agriculture Value	Total
Hail	$8,625	6,074	0.00	$4,709	$39,408
Lightning	$53,447	$35,688	0.00	n/a	$89,135
Hurricane	$63,656	$31,670	0.00	$6,288	$102,614

169 Hazus 100-Year Flood Scenario Report, Building Stock Exposure by Occupancy Type

170 The National Risk Index Community Report for Chittenden County, Vermont, dated May 2, 2022 is included in Appendix D. Retrieved at: https://hazards.fema.gov/nri/report/viewer?dataLOD=Counties&dataIDs=C50007

171 Ibid.

172 The Population Equivalence in the current report was calculated using a value of statistical life (VSL) approach where each fatality or ten injuries is treated as $7.6 million of economic loss.

Strong Wind	$60,173	$119,989	0.02	$434	$180,596
Tornado	$29,572	$31,753	0.00	$9	$61,334

Table 4.7.16: Exposure Values for Severe Rainstorm (hail, lightning, hurricane, strong wind and tornado), Chittenden County[173]

Hazard Type	Building Value	Population Equivalence[174]	Population	Agriculture Value	Total
Hail	$19,727,487.00	$1,189,742,000.00	156,545.00	$43,578,000	$1,209,513,065.00
Lightning	$19,727,487.00	$1,189,742,000.00	156,545.00	$43,578,000	$1,209,513,065.00
Hurricane	$19,672,317.42	$1,186,898,433.33	156,170.85	$43,548,431	$1,206,614,299.00
Strong Wind	$19,727,487.00	$1,189,742,000.00	156,545.00	$43578.00	$1,209,513,065.00
Tornado	$19,727,487.00	$1,189,742,000.00	156,545.00	$43578.00	$1,209,513,065.00

Public Input

A Public Hazard Survey made available to the public during the planning process indicated that approximately 20 percent of the more than 200 survey respondent households had directly experienced severe rainstorm within the previous five years, and most were either very concerned or somewhat concerned about future events. In addition, 72 percent expressed a high level of worry about damage to community lifelines such as schools, utilities, hospitals, etc., and 65% were very worried about damage to or loss of waterways or other natural resources. On a ranking of the most important community assets, survey responders were most concerned about hospitals and other healthcare facilities.

Opportunities for Mitigation

Severe rainstorm and high wind events range widely in terms of location, magnitude, and impact. Most frequently these events are localized and result from heavy rains and winds in a short period of time over urbanized areas that are not able to appropriately handle stormwater runoff. While events of this type do cause damage to property and crops, and can result in federal declarations, many do not rise to this level and are addressed through local resources.

[173] National Risk Index Community Report for Chittenden County, Vermont, dated May 2, 2022. Retrieved at: https://hazards.fema.gov/nri/report/viewer?dataLOD=Counties&dataIDs=C50007
[174] The Population Equivalence in the current report was calculated using a value of statistical life (VSL) approach where each fatality or ten injuries is treated as $7.6 million of economic loss.

Consequently, mitigation goals and actions should focus on severe rainstorms and high wind events that cause damage to buildings and critical infrastructure.

Factors for Consideration in the Next Planning Cycle

Future monitoring, evaluating, and updating of this plan should consider the following factors related to severe rainstorms, including Hurricanes and Tropical Storms.

- Have high wind, severe rainstorm, hurricane, or tropical events been recorded by professional weather experts in the NCEI database or other resources familiar with these hazards?
- Has new scientific research or methodology changed the ability to predict such hazard events?
- Has there been a significant change in the population, built environment, natural environment or economy that could affect the risk or vulnerability to rain- and wind-related hazard events?
- Is there new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to rain- and wind-related events?
- Review the updated Vermont 2018 SHMP update for discussion of new or updated information included in the plan’s section on rain- wind-related events.

SECTION 4.8 SEVERE WINTER STORM (Including Blizzard, Heavy Snow, and Ice Storm)

2022 HMP Update
The 2022 plan update continued to incorporate formatting changes and analyses implemented in the 2017 plan. The Severe Winter Weather hazard was reexamined, and a new analysis conducted. These changes included, but were not limited to: • Refreshing the hazard profiles for each hazard included under this section. • Updating the previous occurrences. • Determining the number of hazard events and losses by jurisdiction using NCEI and other data sources where available. • Updating the assessment of risk by jurisdiction based on new data • Ranking the hazard by jurisdiction using the methodology described in detail in Section 4, Ranking and Analysis Methodologies. • Reformatting sections to improve clarity and, as available and appropriate, incorporate new maps and imagery.

<table>
<tr><th colspan="5">Severe Winter Storm</th><th>Overall Vulnerability</th></tr>
<tr><td colspan="5">Definition, Key Terms, and Overview[175]</td><td rowspan="5">High</td></tr>
<tr><td colspan="5">Elements that may accompany Severe Winter Storms are discussed in this section:
Winter Storm - This term may refer to a combination of winter precipitation, including snow, sleet, freezing rain, etc. that has a hazardous, potentially life-threatening impact.
Blizzard - This life-threatening event is produced by a combination of falling or blowing snow and high winds, typically 35 miles per hour or more for a prolonged period. This combination can create potentially deadly travel conditions with impassable roads and zero visibilities.
Heavy Snow - In Vermont, heavy snow is defined as six or more inches of snow accumulating in a 12-hour period, or nine or more inches accumulating in a 24-hour period.
Ice Storm - An ice storm involves rain, which freezes upon contact called freezing rain. Local National Weather Service (NWS) offices working with key partners (transportation, utilities, and emergency managers) determine potential impacts that would be considered a high impact event. In Vermont, a mean radial ice accumulation of 1/3 to 1/2 inch or more (>0.75* inches Elevated Flat ice) would be considered dangerous, causing impact/damage to trees and utility lines. However, this can vary depending on other factors like wind and additional accumulation of winter precipitation. (NWS forecasts are for Elevated Flat Surface ice accumulation; thus, a conversion is needed to get mean radial ice used by utilities. Mean Radial Ice = Elevated Flat ice * 0.39 inches.)</td></tr>
<tr><th>Frequency</th><th>Probability</th><th colspan="3">Potential Magnitude</th></tr>
<tr><td rowspan="2">High</td><td rowspan="2">High</td><th>Injuries/Deaths</th><th>Infrastructure</th><th>Environment</th></tr>
<tr><td>Low</td><td>High</td><td>Medium</td></tr>
</table>

[175]NOAA National Weather Service, Hazard Weather Definitions
https://www.weather.gov/unr/hwd

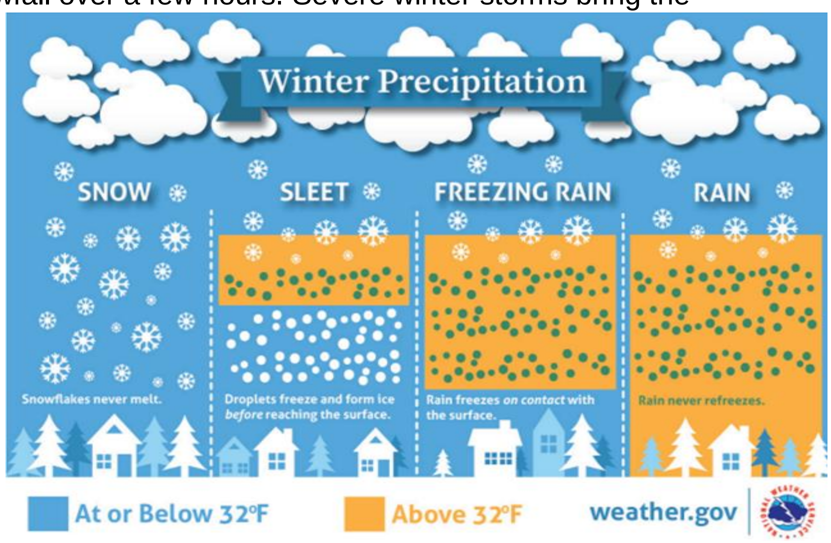
4.8.1 HAZARD PROFILE

Hazard Characteristics are described in full for the four separate, but related hazards included in this section: Winter Storm, Blizzard, Heavy Snow, and Ice Storms

Winter Storm

Winter Storm events have been one of the predominant hazards in Chittenden County since the area was inhabited. More recent history illustrates how much of an impact these events can have on the municipalities' abilities to function. These events result from the collision of high-pressure systems with moderate temperatures and low-pressure systems having lower temperatures. The storms may contain freezing rain, sleet, significant snowfall, and high winds. The complex mixture of moisture, temperature, high pressure, and low-pressure systems creating winter storms is generally unique for each storm. Some severe winter storms can be defined as blizzards and ice storms. During late October through mid-April, temperatures can range between 0 degrees Fahrenheit and 32 degrees Fahrenheit with February having the greatest average snowfall.

Winter storms occur when there is significant precipitation and the temperature is low enough that precipitation forms as sleet or snow, or when rain turns to ice. A winter storm can range from freezing rain and ice to moderate snowfall over a few hours. Severe winter storms bring the threat of heavy accumulations of snow, cold/wind chills, strong winds, and power outages that result in high rates of damage and even higher rates of expenditures. A heavy accumulation of snow, especially when accompanied by high winds, causes drifting snow and very low visibility. Sidewalks, streets, and highways can become extremely hazardous to pedestrians and motorists.



Severe winter storms develop through the combination of multiple meteorological factors. In Vermont and the northeastern United States, these factors include the moisture content of the air, direction of airflow, collision of warm air masses coming up from the Gulf Coast, and cold air moving southward from the Arctic. Significant accumulations of ice can cause hazardous conditions for travel, weigh down trees and power lines, and cause power outages. Freezing rain can also be combined with snowfall, hiding ice accumulation, and further hindering travel, or with mixed precipitation and potentially ice jams or flooding

The most extreme conditions related to severe winter weather are blizzards and ice storms:

Blizzards are the most spectacular and vicious of all winter storms. They are characterized by strong winds (>35 mph) that cause considerable blowing snow, greatly reducing visibility (1/4 mile or less) and causing significant snow drifts. Most blizzards (except ground blizzards) are accompanied by falling snow, although specific snow amounts are not required. Blizzards in the eastern U.S. tend to be accompanied by heavy amounts of snow (12-24 inches or more), whereas in the central U.S. they are due more to blowing snow with snowfall amounts as low as several inches. They have the capacity to completely immobilize large areas.

According to the National Weather Service (NWS), a blizzard occurs when the following conditions last for three hours or longer:

- Considerable falling and/or blowing snow (reducing visibility frequently to less than 1/4 mile)
- Wind speeds of 35 miles per hour (mph) or more

To be considered a severe blizzard, the system must have:

- Wind speeds of 45 mph or more or a great density of falling and/or blowing snow (reducing visibility frequently to near zero)

Heavy Snow events can bring significant snowfall like that experienced during blizzards; however, they are not accompanied by strong winds. They can occur during any severe winter storm event. An intense short-lived burst of heavy snowfall that leads to a quick reduction in visibility is often accompanied by gusty winds and referred to as a snow squall.

Ice storms are a type of severe winter storm characterized by freezing rain which occurs when raindrops move into a thin layer of below-freezing air near the surface of the earth, allowing them to freeze on contact to the ground, trees, overhead utility lines, cars, and other objects. The National Weather Service defines an ice storm as a storm which results in the accumulation of at least 0.5-0.75 Flat inch of ice on exposed surfaces. There are two ways to measure ice: 1 inch of ice on the road is .04 inches on a power line or tree branch, so the diameter would be .08 inches total for the power line or tree branch. Impacts from ice storms are most commonly vehicle accidents and damage to utility infrastructure. Ice accumulation can also collapse roofs on buildings. Impacts can include hazardous driving and walking conditions, and significant damage and/or injury from tree branches and power lines snapping under the weight of the ice.

Location

Most severe winter storm events are “synoptically driven”, meaning they occur over larger geographical areas (counties/states) with some localized (within county/state) differences in coverage and severity.

Winter snow events can impact a large geographical area. During these events, the entire county is impacted, although the impacts are not evenly distributed throughout. Geographically, the county experiences varying snowfall averages. The average annual snowfall for the Western portion of the county including Hinesburg, St. George, Williston, Essex, Westford, Milton, Colchester, Shelburne, Charlotte, Burlington, So. Burlington, and Winooski is 60 inches. The Eastern/foothill portion of the county including Richmond, Huntington, Underhill, Jericho, and Bolton experiences a range of 120 inches at elevations under 1,800 feet and 200 inches at elevations from 2,500 to 4,00 feet.[176]

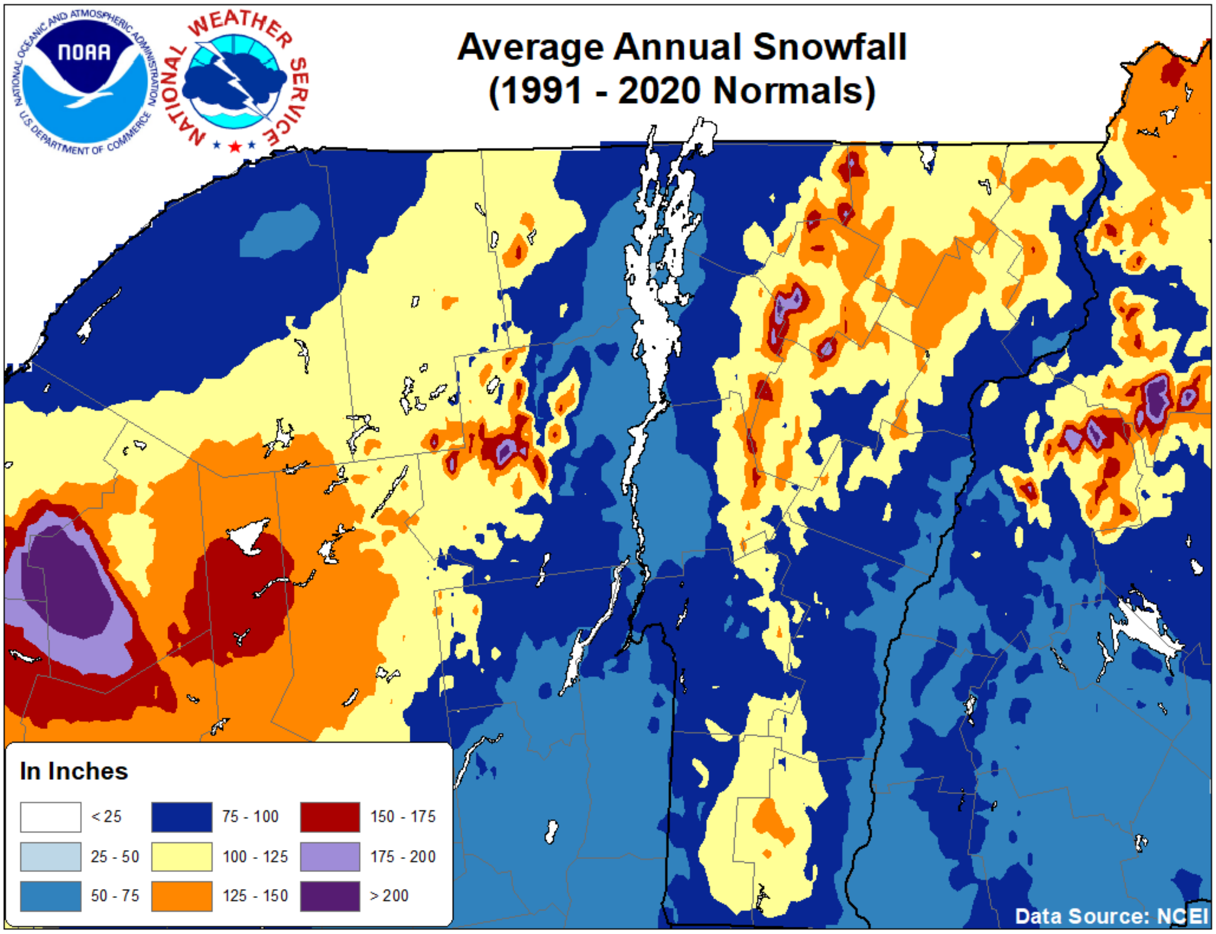


Figure 4.8.1. Annual Average Snowfall in Vermont[177]

Magnitude/Extent/Severity

It is a challenge to gather any extent or location data on Severe Winter Storms as they can range from county-wide events to localized "dumps" of snow, to ice storms, or to light but blowing snow. Sometimes the only visible record of such storms is impacts to travelers in the

[176] National Weather Service, Burlington Airport. Retrieved at: www.weather.gov.btv/climate
[177] National Weather Service, Burlington Airport. Retrieved at: www.weather.gov.btv/climate

form of longer and more challenging driving conditions, cancelled commercial air flights or closed schools or businesses.

The National Oceanic and Atmospheric Administration (NOAA), Weather Prediction Center is in the process of developing an experimental new prediction tool, the Winter Storm Severity Index (WSSI), to provide an indication of the level of winter event severity and impacts. The WSSI does not depict official warnings or exact event timing but provides severity levels over a given period.

Table 4.8.1. Winter Storm Severity Index [178]

WSSI Descriptor	General Description of Expected Storm Severity Impacts
None	No snow or ice forecast. No potential for ground blizzard conditions.
Limited	Small accumulations of snow or ice forecast. Minimal impacts, if any, expected. In general, society goes about their normal routine
Minor	Roughly equates to NWS Advisory Level criteria. Minor disruptions, primarily to those who were not prepared. None to minimal recovery time needed.
Moderate	Roughly equates to NWS Warning Level criteria. Definite impacts to those with little preparation. Perhaps a day or two of recovery time for snow and/or ice accumulation events.
Major	Significant impacts, even with preparation. Typically, several days recovery time for snow and/or ice accumulation events.
Extreme	Historic. Widespread severe impacts. Many days to at least a week of recovery needed for snow and/or ice accumulation events.

The WSSI is broken down into six components that are individually weighted based on the WSSI categories and then summarized into overall severity:

- Snow Amount: to depict severity due to total amount of snow or rate of snowfall accumulation. (Adjustments are made based on climatology and urban areas, e.g., 4" of snow in Atlanta is more severe than 4" in Minneapolis.)
- Snow Load: to depict severity due to total weight of snow on trees and power lines.
- Blowing Snow: to depict severity mainly to transportation due to blowing and drifting snow.
- Ice Accumulation: to depict severity of transportation and downed trees/powerlines due to the accumulated ice in combination with wind.
- Ground Blizzard: to depict severity to mainly transportation of ground blizzards that develop due to a pre-existing snowpack and strong winds.
- Flash Freeze: to depict severity primarily to transportation of situations where temperatures rapidly fall below freezing during precipitation.

[178] National Weather Service, Weather Prediction Center. Retrieved at: https://www.wpc.ncep.noaa.gov/wwd/wssi/wssi.php

The NWS station at the Burlington International Airport located in the City of South Burlington provides a systematic long-term database on average snowfall in the region.

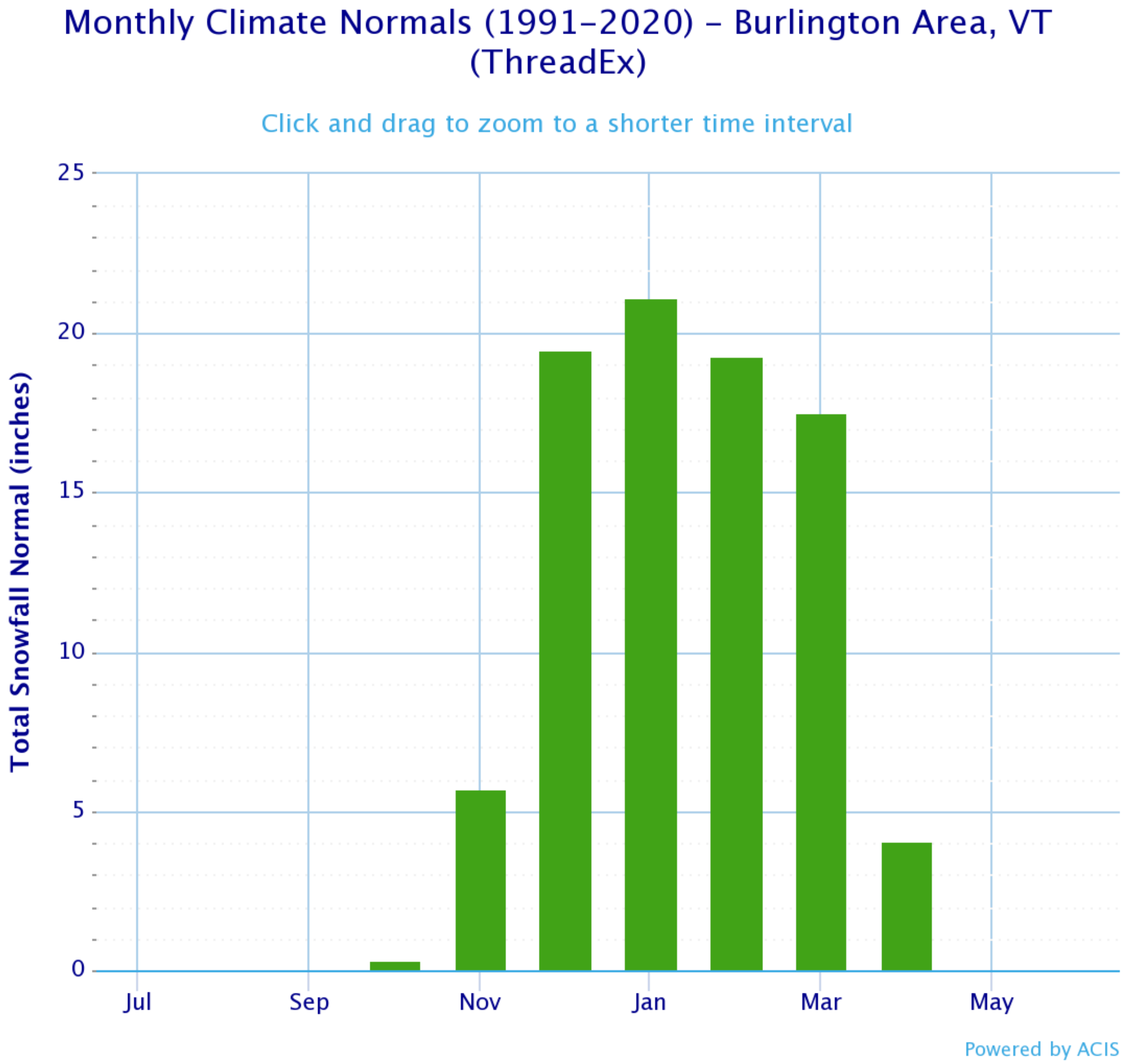


Figure 4.8.2. Average Snowfall by Month, Burlington Internati0nal Airport, South Burlington[179]

Information related to peak Snowfall is described in Tables 4.8.2, 4.8.3, and 4.8.4.

Table 4.8.2. Maximum and Minimum Snowfall Amounts, by Month, Burlington International Airport at South Burlington[180]

---

[179] National Weather Service Office, Burlington International Airport. Retrieved at: https://www.weather.gov/btv/climoSnowfall

[180] National Weather Service, Burlington, VT as of 10/01/2021 http://www.weather.gov/btv/

Maximum				Minimum		
Month	Snowfall	Year(s)	Normal	Month	Snowfall	Year(s)
Jan	48.4"	2010	21.1"	Jan	2.8"	1921
Feb	43.1"	2011	16.4"	Feb	1.3"	1957
Mar	47.6"	2001	15.8"	Mar	Trace	1946
Apr	21.3"	1983	4.6"	Apr	Trace	Many
May	3.9"	1966	0"	May	0	Many
Sep	0.1"	1992	0"	Sep	0	Many
Oct	5.1"	1969/1925	0.3"	Oct	0	Many
Nov	24.0"	1900	5.1"	Nov	Trace	Many
Dec	56.7"	1970	17.0"	Dec	1.4"	1912
Annual	145.4"	1970-71	80.3"	Annual	31.8"	1912-13

Table 4.8.3. Top 20 Greatest Snowstorms, Burlington International Airport at South Burlington[181]

Rank	Snowfall	Dates	Month/Year
1	33.1"	2-3	Jan 2010
2	29.8"	25-28	Dec 1969
3	25.8"	6-7	Mar 2011
4	25.7"	14-15	Feb 2007
5	24.7"	13-14	Jan 1934
6	22.9"	5-6	Mar 2001
7	22.4"	13-14	Mar 1993
8	20.0"	25	Nov 1900
9	19.7"	25-28	Jan 1986
10	19.1"	16-17	Mar 1937
11	18.8"	14-15	Dec 2003
12	18.7"	12-13	March 2014
13	18.3"	6-7	Dec 2003
14	17.8"	3-4	Jan 2003
14	17.8"	4-5	Feb 1995
16	17.7"	3-4	Mar 1994
17	17.2"	6-8	Feb 2008
18	17.1"	25-26	Feb 1966
19	16.9"	25	Dec 1978
20	16.8"	16-17	Jan 1983
20	16.8"	3-4	Mar 1971

Table 4.8.4. Top 10 Seasonal Snowfalls, Winter and Spring, Burlington International Airport at South Burlington

181 National Weather Service, Burlington, VT as of 10/01/2021 http://www.weather.gov/btv/

Winter (Dec-Feb)

Highest			Lowest		
Rank	Snowfall	Year(s)	Rank	Snowfall	Year(s)
1	103.4"	2007-08	1	18.4"	1912-13
2	97.9"	2010-11	2	20.4"	1979-80
3	96.9"	1970-71	3	21.9"	1928-29
4	90.1"	2009-10	4	23.6"	1936-37
5	81.7"	1965-66	5	24.0"	1898-99
6	80.7"	2003-04	6	25.0"	1904-05
7	80.0"	1957-58	7	25.6"	1940-41
8	79.4"	2008-09	8	26.3"	2011-12
9	78.6"	1946-47	9	27.0"	1900-01
10	75.7"	1969-70	10	27.4"	1960-61

Spring (Mar-May)

Highest			Lowest		
Rank	Snowfall	Year(s)	Rank	Snowfall	Year(s)
1	52.7"	1993	1	0.1"	1945
2	47.8"	2001	2	1.0"	1903
3	45.7"	1971	3	2.0"	1910
4	37.7"	1974	4	2.7"	1927
5	36.4"	1916	5	3.1"	1934
6	36.1"	1997	6	3.2"	1991
7	34.4"	1994	7	3.9"	1946
8	33.9"	1983	8	4.0"	1905
9	31.0"	2007/1972	9	4.1"	1915
10	30.1"	2011	10	4.2"	1921

Previous Occurrences

The NOAA, National Centers for Environmental Information (NCEI) documents severe winter storm events for Chittenden County in its Storm Events Database. These events occurred throughout the planning region but vary widely in terms of location, magnitude, and impact. Where possible, NCEI tracks reports separately by impacted jurisdiction, although it is not always possible to document damages below a county or city level. For severe winter weather events, the damages were reported under three different zones (Chittenden Zone, Eastern Chittenden Zone and Western Chittenden Zone) to include damages that occurred within both cities and towns. In most instances, the only visible record of such storms is impacts to travelers in the form of longer and more challenging driving conditions, cancelled commercial air flights or closed schools or businesses.

The Storm Events Database (under categories for winter storm, winter weather, heavy snow, and ice storm[182]) documents 379 **severe winter storm** events in Chittenden County between 1950 and June 30, 2021, totaling approximately $10,654,500 in property damage and $25,000 in crop damage, and resulting in three injuries and two deaths. Nine (9) severe winter weather events occurred between January 2017 and June 2021.

Table 4.8.5. Total Impact of Severe Winter Weather-Related Hazards in Chittenden County, 1950 to June 2021[183]

Location	Type	# of Events	Death	Injuries	Property Damage (Dollars)	Crop Damage (Dollars)
Chittenden Zone	Winter Storm	24	-	2	595,000	-
	Winter Weather	36	1	-	2,002,000	-
	Heavy Snow	5	-	-	52,000	-
	Ice Storm	1	-	1	2,500,000	-
Sub-Totals		66	1	3	5,149,000	-
Eastern Chittenden Zone	Winter Storm	74	-	-	1,198,000	25,000
	Winter Weather	80	-	-	799,000	-
	Heavy Snow	3	-	-	105,000	-
	Ice Storm	1	-	-	750,000	-
Sub-Totals		158,000	-	-	2,852,000	25,000
Western Chittenden Zone	Winter Storm	66	-	-	1,613,000	-
	Winter Weather	85	1	-	595,500	-
	Heavy Snow	3	-	-	245,000	-
	Ice Storm	1	-	-	200,000	-
Sub-Totals		19	1	-	2,653,5000	-
Totals		**379**	**2**	**3**	**$10,654,500**	**$25,000**
These figures do not include vehicle accidents or other costs to the municipalities from the storms.						

Table 4.8.6. Winter Storm History[184]

[182] The NCEI Storm Events Database does not document any blizzard events within this time period.
[183] NOAA, National Centers for Environmental Information (NCEI), Storm Events Database for January 1, 1950 to June 30, 2021. Damage costs presented in year of occurrence values, as reported by the NCEI.
[184] National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), Storm Events Database for January 1, 1950 to June 30, 2021.

Type of Event	Dates	Description
Blizzard	December 26-27, 1969	Snow amounts between 18–36” in northwestern Vermont and 45” in Waitsfield. Governor Dean Davis declared a State disaster. Drifts of snow from the storm piled up to 30 feet in places.
Ice Storm	January 6, 1998 (DR-1201):	An unusual combination of precipitation and temperature led to the accumulation of more than 3 inches of ice in many locations, causing closed roads, downed power lines, and damage to thousands of trees. This storm was estimated as a 200- to 500-year event. Power was out up to 10 days in some areas and 700,000 acres of forest were damaged in Vermont. Vermont suffered no fatalities, unlike Quebec where 3 million people lost power and 28 were killed. Temperatures rose after the storm, causing the ice to melt and permitting crews to reopen roads, which kept many residents from freezing in their unheated homes. Over $6 million worth of estimated property damage.
Snowstorm	March 2001:	A string of storms hit Vermont in March 2001, beginning with 15-30 inches of snow on March 5-6, 10-30 inches on March 22, and 10-20 inches on March 30.
Snowstorm	February 14, 2007	According to the National Climatic Data Center (former name of the NCEI), a weather station in South Burlington reported a record 25.3 inches of snow in 24 hours. Some parts of Chittenden County received over 30 inches of snow. Snow-blocked furnace vents caused multiple carbon monoxide incidents. Traffic accidents and barn roof collapses were also reported. There was no severe power loss; however, snow removal operations took over a week in some parts of the county.
Snowstorm	January 2-3, 2010	Burlington experienced the most significant snowfall on record from one event with 33.1 inches of snow.
Winter Snow	2010-2011 [Multiple Dates]	Winter Snow Totals, 2010-2011: The winter of 2011 was the second snowiest on record for Vermont, with a total of 128.4 inches of snow. A March blizzard in Burlington brought 25.8 inches of snow in two days. The storm closed schools for days, and many people were without power. Driving was hazardous due to a 1-inch layer of ice beneath several inches of snow.
Snowstorm	December 28, 2011	A strong cold front moved across Vermont during the late morning and afternoon hours accounting for a rapid cool down and localized snow squalls with heavy snow. The western slopes of the Green Mountains saw 5-12 inches of snow along foothill communities. Near white-out conditions in snow squalls and rapidly freezing road ways accounted for numerous vehicle accidents as well as a closure of I-89 between Richmond and Waterbury.
Snowstorm	November 26, 2014	The storm began late morning November 26 and increased in intensity, falling at rates at or greater than 1 inch per hour. Snowfall caused slow and difficult travel the day before Thanksgiving. Snow continued through the day and evening with heavy bands at times and tapered off overnight. By the early morning on Thanksgiving,

Type of Event	Dates	Description
		most of southern Vermont saw snowfall of 8-15 inches with the heaviest amounts across the higher elevations of the southern Green Mountains.
Snowstorm	December 9-13, 2014 (DR-4207)	Rain and wet snow moved into Vermont midday December 9 and changed to a heavy, wet snow during the evening. A band of moderate snowfall impacted much of central and northern Vermont during the afternoon and evening hours of December 10, then scattered snow showers ending on December 11-12. Total snowfall totals across Vermont ranged from 3-6 inches in Essex County to 12-20 inches across the Green Mountains into the Champlain Valley. The heavy, wet nature of the snowfall with snow to water ratios of 8:1 or less accounted for snow-loaded trees that resulted in more than 175,000 power outages in the region. This was the second most power outages due to weather in Vermont. Over $4 million in property damages estimated.
Snowstorm	March 14-15 2017	A major nor'easter developed off the North Carolina/Virginia coast during the early morning hours of March 14th and intensified as it moved north-northeast across southeast New England during the night into central Maine by the morning of March 15th.Snow developed across Vermont by mid-morning on the 14th and intensified to at least 1 to 3 inches per hour for several hours during the late afternoon and overnight hours before gradually diminishing late on the 15th. There were numerous sites that witnessed 4 to 5 inches per hour snowfall rates for more than one hour. In addition, blizzard to near blizzard conditions developed around the time of the heaviest snowfall and lasted for 3-4 hours within several miles of Lake Champlain and some higher exposed terrain as well. Total snowfall across Vermont was 12 to 36+ inches with northwest Vermont experiencing the heaviest snowfall. Numerous schools, businesses and local government offices closed for March 14th and 15th with numerous vehicle accidents and stranded vehicles.

Smaller, less extensive ice storms have occurred in the county commonly affecting a few towns at one time. Most recently in the winter of 2014 - 2015, two such storms occurred and caused enough damage in several towns to warrant Federal Disaster declarations (DR-4163 and DR-4207).

Between 1964 and 2021, six Severe Winter Storm events in Chittenden County have been significant enough to be included in Federal Disaster Declarations. Although several long-duration events with heavy snow accumulation have occurred in the Planning Area since 2017, causing power outages, school and business closures, and transportation issues, there have been no Federal Disaster Declarations for severe winter storms that include Chittenden County since the last plan update.

Table 4.8.7. Severe Winter Storm Disaster Declarations in Chittenden County (1964 - 2021)[185]

Disaster Number	Event Type Individual Assistance (IA) Public Assistance (PA)	Declaration Date	Damage Amount
DR-4207-VT	***Vermont Ice Storm***	December 9-13, 2014	[Not Available]
DR-4163-VT	***Vermont Ice Storm***	December 20-21, 2013	[Not Available]
DR-1816-VT	***Vermont Ice Storm*** - PA	December 11, 2008	[Not Available]
EM-3167[186]	***Vermont Snowstorm (9 counties)***	April 10., 2011	FEMA Obligated Dollars as of 03/20/2020 PA (Cat. B) - $1,296,992.34
DR-1358-VT	***Vermont Snow Storm***	December 19, 2000	[Not Available]
DR-1201-VT	***Vermont Severe Ice Storms,***	January 6, 1998	[Not Available]

Probability of Future Occurrence

Since severe winter weather events are difficult to predict, it is extremely difficult to determine probability of future occurrence with any degree of accuracy. It can, however, with considerable confidence, based on historical record, be projected that Chittenden County will continue to experience severe winter weather events with great frequency.

Probability calculations for severe winter storm events can be derived from several sources. Based on analysis of previous events in the NCEI database, it appears that those events causing injuries, deaths or damage have occurred on a seemingly random basis with no specific portion of the county more likely to experience them than any other. A total of 379 severe winter weather events were recorded between 1950 and the September 2021, or roughly 71 years. This averages out to 5.33 severe winter weather events annually, which indicates a high likelihood of future occurrence.

The **National Risk Index (NRI)** also provides an annualized frequency value for multiple natural hazards, including Ice Storm and Winter Weather. The NRI calculation of events per year is based on the number of events on record over a period of 24 years (1996-2019)[187].

Table 4.8.8: NRI Annualized Frequency Values for Hazard Event Types Related to Severe Winter Storm (Number of Events per Year)[188]

[185] Federal Emergency Management Agency (FEMA)
[186] EM-3167 was declared for a snowstorm leading to snow melt and associated runoff due to the spring melt, that resulted in lakeshore flooding on Lake Champlain continuing into May 2001.

[187] National Risk Index, Retrieved at: https://www.fema.gov/flood-maps/products-tools/national-risk-index
[188] National Risk Index Community Report for Chittenden County, Vermont, dated May 2, 2022. Retrieved at: https://hazards.fema.gov/nri/report/viewer?dataLOD=Counties&dataIDs=C50007

Ice Storm	Winter Weather
0.3	7.0

Climate change is projected to increase the frequency and intensity of extreme weather events, including severe thunderstorms. Using global climate models and a high-resolution regional climate model, one study that investigated the link between severe thunderstorms and global warming found a net increase in the number of days with environmental conditions that foster the development of severe winter storms. This was true for much of the United States, including Chittenden County

Table 4.8.9. Severe Winter Storm Hazard Profile Summary

Severe Winter Storm (Including Blizzard, Heavy Snow, and Ice Storm): HIGH RISK HAZARD			***Potential Cascading Effects***
	Location	Jurisdiction-wide	• Power/utility outages (No heat) • Temporary traffic/roadway damage or closures • Public health and safety • Responder health and safety • Temporary school/business closures
	Extent	Mild to severe impacts to people, property, structures, and environment	
	Duration	Several hours to several days	
	Probability	High	
	Seasonal Pattern	Winter, Early Spring	
	Speed of Onset	Slow to Rapid	
	Warning Time	Hours to days	
	Repetitive Loss	N/A	

4.8.2 RISK ASSESSMENT

Risk, defined as probability multiplied by impact, cannot be fully estimated for damaging winter storm, heavy snow and ice storm events due to the lack of intensity-damage models for these hazards. Instead, financial impacts of damaging winter storm events are illustrated using data included from the NCEI Storm Events Database. While multiple communities often submitted reports for the same incident, each report describes how the event affected the jurisdiction. During the cited period, there were two deaths and three injuries directly related to severe winter storm events; however, the entire population across the Chittenden County is at risk. Given the countywide reported total of $10,654,500 in property damage and $25,000 in crop damage, figures show that structures and agricultural assets are at risk to severe winter weather events.

People

There are people 168,323 living in the planning area according to the 2020 U.S. Census Bureau figures, the most recently available official data. Severe winter weather events may affect the entire population, but those living in communities along Lake Champlain are particularly at risk to winds and storms approaching from over the waterway. Extremely cold air comes every winter in at least part of the country, frequently in combination with winter storms, and affects millions of people across the United States. The arctic air, together with brisk winds, can lead to dangerously cold wind chill values. People exposed to extreme cold are susceptible to frostbite in a matter of minutes. Areas most prone to frostbite are uncovered skin and the extremities, such as hands and feet. Hypothermia is another threat during extreme cold. Hypothermia occurs when the body loses heat faster than it can produce.

Built Environment

Community Lifelines

Quantitative assessment of critical facilities for winter storm risk was not feasible for this update because such events are not geographically specific and are likely to affect the entire planning area. Heavy accumulations of snow can cause roof failure on residential and commercial structures. Heavy accumulations of ice can bring down trees and topple utility poles and communication towers. Ice can disrupt communications and power for days while utility companies repair extensive damage. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces.

It is important to note that not all critical facilities have redundant power sources, and structures may not be wired to allow the addition of an emergency backup generator for residential or commercial use. Future plan updates should consider including a more comprehensive examination of critical facility vulnerability to severe winter weather events, and if it is determined to be a high mitigation priority, included in the mitigation strategy actions to upgrade generator capacity at essential facilities.

Nonetheless, maintaining continuity of operations of transportation, infrastructure, utilities, and government assets is critical to minimizing economic damage that may result from businesses being unable to provide services, or move equipment or products.

Existing Buildings and Infrastructure Risk

Risk to existing buildings and infrastructure is largely determined by building construction type. What is known is that age of construction plays a role in vulnerability of facilities to severe winter weather events. Concrete, brick, and steel-framed structures tend to fare better in severe winter storm events than older, wood-framed structures. Electric outages are caused by falling limbs, trees, and poles, by power lines slapping together; and by flying debris, all of which affects the build environment.

Natural Environment and Economy

Communities within the planning area include natural assets vulnerable to severe winter weather events. These events may topple trees, streetlights, and power poles and damage fabric shelters set up in the area's federal, state, and local parks. Additionally, cold weather can also affect crops. In late spring or early fall, cold air outbreaks can damage or kill produce for farmers, as well as residential plants and flowers. Freezes and their effects are significant during the growing season. Each plant species has a different tolerance to cold temperatures

Changes in Development

The planning area's vulnerability to severe winter storm events has remained constant overall. No significant new development has taken place, nor have older structures been removed, which would increase or decrease the probability or risk of this hazard in the remote areas. This validates what was previously identified in the 2017 *MJAHMP*.

Hazard Risk Ranking

Each jurisdiction in the Planning Area conducted a risk analysis to consider impacts, consequences (including magnitude/severity), and probability of future occurrences to determine the Overall Risk Rating for severe winter storm.

Table 4.8.10: Severe Winter Storm Hazard Risk Rating Summary, All Municipalities

JURISDICTION	Sum - Impact/ Consequence Score	Probability	Total Risk Rating *(Impact/ Consequences x Probability)*	Hazard Ranking
Bolton	8	5	40	High
Buels Gore	10	4	40	High
Burlington	6	3	18	Medium
Charlotte	6	4	24	Medium
Colchester				
Essex	11	5	55	High
Essex Junction	11	5	55	High
Hinesburg	10	5	50	High
Huntington	8	5	40	High
Jericho	11	5	65	High
Milton	8	5	40	High
Richmond	8	5	40	High
Shelburne	6	4	24	Medium
South Burlington	7	5	35	Medium
St. George	9	5	45	High
Underhill	11	5	55	High
Westford	11	5	55	High
Williston	9	5	45	High

JURISDICTION	Sum - Impact/ Consequence Score	Probability	Total Risk Rating *(Impact/ Consequences x Probability)*	Hazard Ranking
Winooski	9	5	**45**	High
AVERAGE TOTAL RISK SCORE			43.7	High

The compilation of jurisdiction risk scores, along with consideration of the hazard profile and potential impacts and consequences, indicates that **severe winter storm** is a **high-risk** hazard for fifteen municipalities, and a **medium-risk** hazard for four municipalities within the Planning Area. Consequently, a vulnerability assessment is appropriate to identify the level of exposure to the municipalities within the Planning Area.

4.8.3 VULNERABILITY ANALYSIS

The entire planning area faces uniform susceptibility to the effects of severe winter weather events, including winter storms, winter weather, heavy snow, and ice storms. As is the case with risk from hurricane and tropical storm force-winds, the most at-risk buildings to severe winter weathers are assumed to include manufactured homes and older residential structures. Another great concern for Chittenden County with regard to severe winter weather events is damage to electric power lines which regularly cause power outages for residents and businesses across the area, and have disrupted the availability of emergency services, including 911. During past events, severe winter storm events have downed trees across power lines, snapped utility poles and even blown down transformers resulting in widespread outages. Downed power lines create a dangerous threat to public safety; while difficult to quantify, long-term power outages can result in significant hardship for residents and major economic impacts for local businesses.

General Exposure

The exposure to severe winter storm events is primarily related to loss of population, residential structures and infrastructure, and direct economic loss if forest-based businesses are impacted; however, detailed data related to specific properties or infrastructure is not available for this plan update.

Exposure Annualized Loss
One method for measuring vulnerability is used as a comparative tool for this Plan update. The **National Risk Index (NRI)** assessment includes an Expected Annual Loss (EAL) calculation which quantifies loss for relevant consequence types (buildings, people and agriculture) for multiple hazards including ice storm and winter weather. The EAL is calculated using a

multiplicative equation that includes exposure, annualized frequency, and historic loss ratio risk factors.[189]

Table 4.8.11: Expected Annual Loss Values for Ice Storm and Winter Weather, Chittenden County[190]

Hazard	Building Value	Population Equivalence[191]	Population	Agriculture Value	Total
Ice Storm	$137,961	$30,099	0.00	N/A	$168,060
Winter Weather	$63,314	$54,391	0.01	$28	$117,733

Table 4.8.11: Exposure Values for Ice Storm and Winter Weather, Chittenden County

Hazard	Building Value	Population Equivalence[192]	Population	Agriculture Value	Total
Ice Storm	$19,724,739,844	$1,189,574,071,343	156,522.90	N/A	$1,209,298,811,186
Winter Weather	$19,727,349,099	$1,189,738,209,807	156,544.50	$43,564,843	$1,209,509,123,749

Potential Impacts of Climate Change

As the climate continues to change, the severity of storms may increase, producing more severe winter weather events, and consequently, causing more losses. This in turn may require more emergency management response resources and hardening of vulnerable infrastructure such as power poles and utility lines

Public Input Related to Severe Winter Storms

A Public Hazard Survey made available to the public during the planning process indicated that approximately 0.84 percent of the more than 200 survey respondent households had directly experienced severe winter storms within the previous five years, and most had very little concern about future severe winter weather events. In addition, more than 66 percent were either slightly

[189] The National Risk Index Community Report for Chittenden County, Vermont, dated May 2, 2022, is included in Appendix D.
[190] Community Report, National Risk Index, dated May 2, 2022. Retrieved at: https://hazards.fema.gov/nri/report/viewer?dataLOD=Counties&dataIDs=C50007
[191] The Population Equivalence in the current report was calculated using a value of statistical life (VSL) approach where each fatality or ten injuries is treated as $7.6 million of economic loss.
[192] The Population Equivalence is calculated

concerned or not concerned about impacts to people, businesses, or properties from severe winter weather events. On a ranking of the most important community assets, survey responders were most concerned about hospitals and other healthcare facilities, which have a very low threat from severe winter storm events.

Opportunities for Mitigation

Severe winter weather protection is more effective when a homeowner or business owner exercises personal initiative to take measures that protect his or her own property. Therefore, public education and awareness plays a greater role in such areas. In areas with strict building codes, property owners who resist maintaining the minimum codes can be cited for failure to maintain property in a safe manner.

Factors for Consideration in the Next Planning Cycle

Future monitoring, evaluating, and updating of this plan should consider the following factors related to severe winter storm events as well as other information from the *VT SHMP* updates:

- Have any severe winter storm events occurred since adoption of this plan?
- Has any new scientific research or methodology changed the ability to predict severe winter storm events or assess risk and vulnerability?
- Has there been any significant change in the population, built environment, community lifelines, natural environment, or economy that could affect the risk or vulnerability to severe winter storms?
- Is there any new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to severe winter storm events?

SECTION 4.9 WILDFIRE

2022 MJAHMP Update

The 2022 plan update continued to incorporate formatting changes and analyses implemented in the 2017 plan. These changes included, but were not limited to:

- The Wildfire hazard was reexamined, and a new analysis performed.
- The hazard profile was refreshed and expanded under this section.
- Previous occurrences were updated.
- Determined number of hazard events and losses by jurisdiction using National Centers for Environmental Information (NCEI) and other data sources where available.
- Updated the assessment of risk by jurisdiction based on new data.
- New jurisdiction hazard rankings were conducted using the methodology described in detail in Section 4, Ranking and Analysis Methodologies.
- Reformatted sections to improved clarity.
- Incorporated new maps and imagery, as available and appropriate.

<table>
<tr><th colspan="5">Wildfire</th><th>Overall Vulnerability</th></tr>
<tr><th colspan="5">Definition, Key Terms, and Overview</th><td rowspan="5">Low</td></tr>
<tr><td colspan="5">The 2017 Vermont Forest Action Plan, developed by the Department of Forests, Parks and Recreation, defines wildland fire as any non-structure fire that occurs in vegetation or natural fuels, including prescribed fire and wildfire.</td></tr>
<tr><th rowspan="2">Frequency</th><th rowspan="2">Probability</th><th colspan="3">Potential Magnitude</th></tr>
<tr><th>Injuries/Deaths</th><th>Infrastructure</th><th>Environment</th></tr>
<tr><td>Low</td><td>Low</td><td>Low</td><td>Low</td><td>Medium</td></tr>
</table>

4.9.1 HAZARD PROFILE

A wildfire is the uncontrolled burning of woodlands, brush, or grasslands. According to the Federal Emergency Management Agency (FEMA), there are four categories of wildfires that can occur throughout the United States:

- **Wildfires:** Fueled by natural vegetation; typically occur in national forests and parks, where federal agencies are responsible for fire management and suppression.

- **Interface or Intermix Fires**: Urban wildfires in which vegetation and the built environment provide fuel.

- **Firestorms**: Events of such an extreme intensity that effective suppression is virtually impossible. They occur during extreme weather and generally burn until conditions change, or the available fuel is exhausted.

- **Prescribed Fires and Prescribed Natural Fires**: Fires that are intentionally set or selected natural fires that are allowed to burn for beneficial purposes.

Wildfires can be a result of naturally occurring influences such as lightning, drought and extreme heat (see Drought, Extreme Temperature/Heat), and human influences such as a discarded cigarette, improperly extinguished campfire, or a stray spark from nearby railroad tracks. The potential for the threat of wildfires is dependent upon topography and slope, surface fuel characteristics, recent climate conditions, current meteorological conditions, and fire behavior. Once a wildfire threatens a community, it is often too late to protect nearby structures, and populations must be evacuated for their own safety. These fires could have the potential to damage structures and utilities as well as hundreds of acres of woodlands.

Most wildland fires in Vermont are quickly reported and contained, though fires burning deep in ground fuels or in remote locations require more time and effort to fully suppress. Town Forest Fire Wardens and local fire departments primarily handle wildland fire control with assistance from other towns and the State, when necessary. Vermont has a reliable system of local fire suppression infrastructure coordinated at the state level. Vermont's climate, vegetation type, and landscape discourage major wildfires. Most fires in Vermont are caused by burning debris.

Location

There is no specific geographic area of the county particularly more vulnerable to wildfire, given that 51.52 percent of the county is forested, and 2.43 square miles of the forest was lost between 2001 **and** 2019.[193] In general, wildfire risk is considered statewide, though a specific location where infrastructure and life are potentially more vulnerable to structural fire is the wildland-urban interface (WUI). The WUI represents the area where infrastructure and some level of development interacts with undeveloped land, creating the potential for fire to move from a forested environment to a grassed neighborhood. Despite not having had a major wildfire in the last 50 years, fire suppression systems are in place at the local level. These involve burn permits, burn restrictions, prevention education, and detection of fires. Wildfire is an even less serious threat in parts of Chittenden County that are relatively urbanized, especially the Burlington area.

Table 4.9.1. Forests in Chittenden County[194]

Forest	Location
Mount Mansfield State Forest	Bolton, Underhill
University of Vermont Talcott Forest	Williston
Hinesburg Town Forest	Hinesburg
Camels Hump State Forest	Huntington
Andrews Community Forest	Richmond
Essex Junction Village Municipal Forest	Essex Junction Village

---

[193] NOAA, National Land Cover Dataset. Retrieved at: https://www.mrlc.gov/eva/?c=50007&fr=2001&r=county&s=50&t=3&to=2019

[194] NOAA, National Land Cover Dataset. Retrieved at: https://www.mrlc.gov/eva/?c=50007&fr=2001&r=county&s=50&t=3&to=2019

Forest	Location
Arms Forest	Burlington
Milton Town Forest	Milton

Extent

The National Weather Service (NWS) monitors forecast trends for critical weather conditions that support extreme fire behavior and coordinates with fire weather partners in determining status of the fuels for issuance of Fire Weather Watches and Red Flag Warnings. Through the Red Flag Program, the NWS alerts land management agencies of developing weather conditions that, when coupled with critically dry wildland fuels, could lead to potentially dangerous fire situations. Coordination is made between NWS Burlington and fire weather partners before issuance of a Fire Weather Watch or Red Flag Warning.[195]

The NWS issues a Red Flag Warning when there is the potential for extreme fire danger within 24 hours based on the following criteria:

- Vegetative Stage I & II (cured & transition – Winter/Spring/Fall)
  - Winds sustained or with frequent gusts > 25 mph.
  - Relative Humidity at or below 30 percent anytime during the day.
  - Rainfall amounts for the previous 5 days less than 0.25” (except 3 days in pre-green up).
  - Lightning after an extended dry period.
  - Significant dry frontal passage.
- Vegetative Stage III (green - Summer)
  - Winds sustained or with frequent gusts above 25 mph - Relative Humidity at or below 30 percent.
  - Rainfall amounts for the previous 8 days of less than 0.25 inches.
  - Keetch-Byram Drought Index values of 300 or greater.

[195] Fire Weather Annual Operating Plan for Much of Vermont and Northern New York, National Weather Service, Burlington, VT, 2021 (updated 3/10/2020) https://www.weather.gov/media/btv/firewx/NWSBurlingtonAOP.pdf

Fire managers also use the National Fire Danger Rating System, a system that estimates the fire danger for a given area. It combines the various factors of fuels, weather, topography, and risk which affect the potential for wildfires in an area. Fire danger in Vermont is expressed as a daily adjective rating published daily by the Vermont Department of Forests, Parks and Recreation. Chittenden County is divided between Fire Danger Rating Areas 3 and 4.

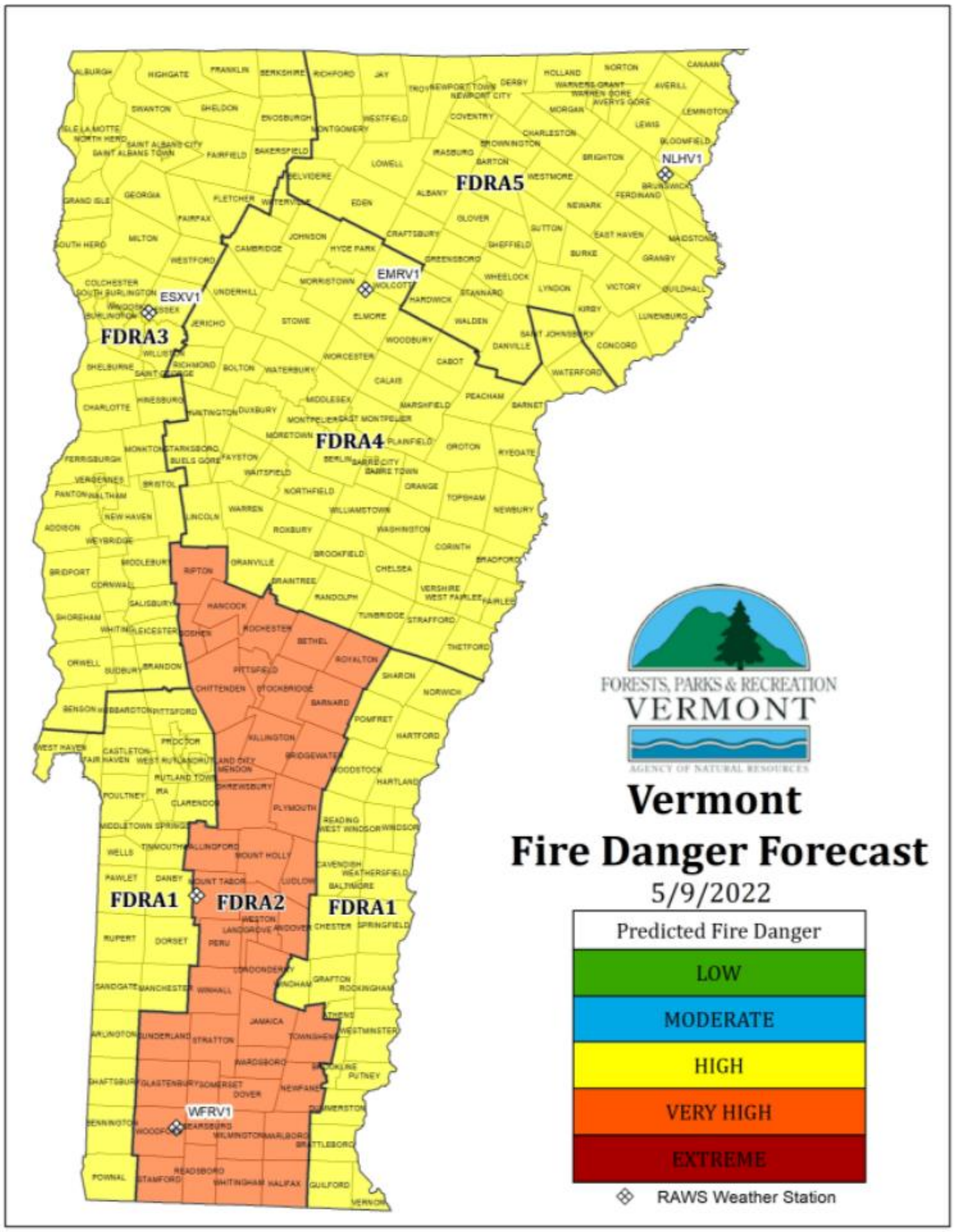


Figure 4.9.1: Fire Danger Rating Area Status, May 9, 2022[196]

[196] Vermont Forests, Parks and Recreation, Agency of Natural Resources, May 9, 2022. Retrieved at: https://fpr.vermont.gov/forest/wildland-fire/monitoring-fire-danger

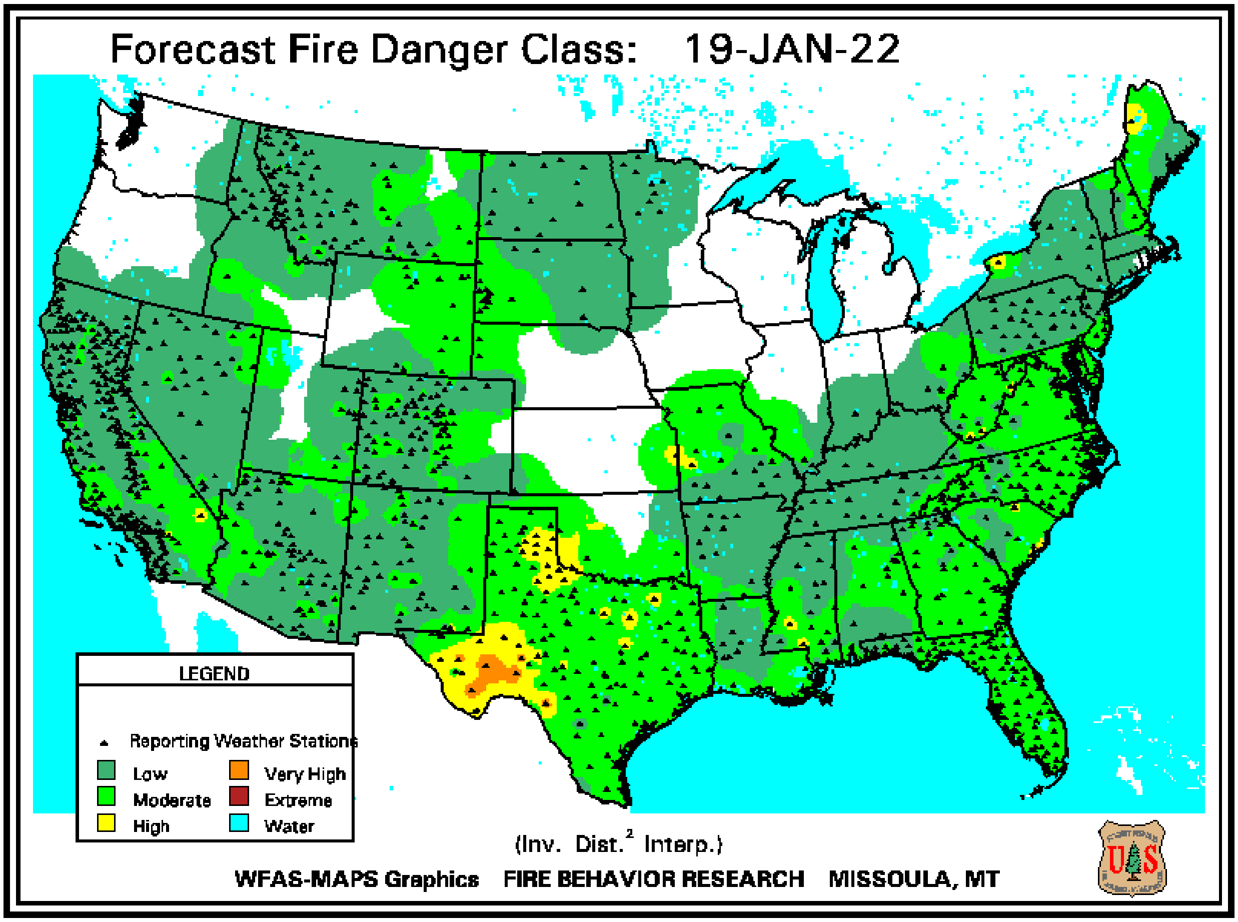


Figure 4.9.2. Forecast Fire Danger Rating[197]

The Ketch-Byram Drought Index (KBDI) is a drought index specifically for fire potential assessment. This system, originally developed for the Southeastern United States, is based primarily on recent rainfall patterns, and was specifically established to correlate the effects of drought with potential fire activities. In Vermont it is primarily used to predict potential for larger fuels to burn and ground fire activity.

The KBDI attempts to measure the amount of precipitation needed to bring the top eight inches of soil back to saturation. A value of zero represents complete soil saturation or no moisture deficiency. A value of 800, the maximum fire drought indicator possible, means it would take eight inches of precipitation to fully saturate the soil. At any point in between, the KBDI number indicates the amount of precipitation it would take to bring the moisture level back to zero. High KBDI values indicate that conditions are favorable for the occurrence and spread of wildfires. The following shows how KBDI and expected fire potential relate.

[197] https://www.wfas.net/index.php/fire-danger-rating-fire-potential--danger-32/class-rating-fire-potential-danger-51?task=view

Table 4.9.2. Ketch Byram Drought Index (KBDI)[198]

KBD	Expected Fire Potential
KBDI = 0 – 200	Soil and fuel moisture are high. Most fuels will not contribute to wildfire intensity. This condition is often seen in the spring after winter precipitation.
KBDI = 200 – 400	Fuels are beginning to dry and contribute to wildfire intensity. Heavier fuels will still not readily ignite and burn. This condition is often seen in late spring.
KBDI = 400 – 600	Wildfire intensity begins to increase significantly. Wildfires will readily burn, and larger fuels could burn or smolder for several days. This is often the case during late summer and early fall.
KBDI = 600 – 800	Wildfires show extreme intensity. Deep-burning, intense wildfires with significant spotting can be expected. This often occurs during a severe drought.

Using the KBDI index is a good measure of the readiness of fuels for wildland fire. Caution should be exercised in dryer, hotter conditions, and the KBDI should be referenced as the area experiences changes in precipitation and soil moisture.

Note: Some discussion about KBDI does not relate to the majority of fires in Chittended County, as the KBDI is more appropriately used as a drought index. KBDI is an excellent measure of ground fire potential and moisture in larger fuels. Ground fires are expected in remote areas in summer months when KBDI is above 300. However, the majority of the fires in the county are in early spring when KBDI is below 100. Fire danger can be very high in fine surface fuels with very low KBDI.[199]

Previous Occurrences

The primary forms of wildfire in Chittenden County are brush fires and grass fires accidentally started by persons burning trash, leaves, and brush.

Although the NOAA, NCEI Storm Events Database includes wildfire as an event type, records indicate no reported events for the period from 1950 to 2022.

Wildfire statistics from the Vermont Department of Forests, Parks, and Recreation reports 154 wildfire events have occurred burning 224.45 acres in Chittenden County between 2003 and 2021. Most fires burned less than twenty acres. Wildfires from natural causes such as lighting are sporadic but generally have remained localized events with little significant damage to persons or property other than the grassland or woodland consumed. During times of dry weather coupled with dry fuels, Burn Bans are occasionally issued by local and state authorities. Red Flag Warnings or fire weather watches may also be issued from he National Weather Service. Fires are not limited to "wildland" or forested areas but are most often in the WUI.

[198] www.drought.gov
[199] Dan Dillner, National Weather Service, Burlington.

Table 4.9.3. Recorded Wildfires in Chittenden County 2003-2021[200]

Chittenden Wildfire Information		
Year	#	**Acres**
2003	3	8
2004	3	9
2005	20	19.31
2006	7	2.46
2007	5	3.96
2008	12	11.08
2009	2	3.9
2010	9	23.95
2011	8	20.75
2012	5	3.75
2013	19	22.38
2014	5	7
2015	14	26.3
2016	12	44.5
2017	7	2.37
2018	12	7.66
2019	-	-
2020	11	8.08
Totals	154	224.45

April 2016, a small brush fire occurred in South Burlington, emblematic of the county's "suburban" towns. According to the South Burlington Fire Department Chief when firefighters arrived on the scene an area about the size of five football fields was burning. About thirty firefighters from the City of South Burlington and three other agencies worked to contain and extinguish the blaze. The spring had been preceded by a winter with very little snowfall in the county.

Despite the lack of wildfire events reported through systematic data collection, the Chittenden County Regional Planning Commission (CCRPC) and its member municipalities recognize the damages that have been caused from past events and could be caused by this hazard in the future and therefore have included it in this *MJAHMP*.

Probability of Future Occurrence

---

[200] Vermont Department of Forest, Parks, and Recreation; https://fpr.vermont.gov/forest/vermonts-forests/division-forests

Given the low occurrence of wildland fires in Vermont, the risk is considered to be relatively low. However, the vulnerability to wildfires is constantly changing. Predictive models for fire potential are often generated each month or season. These models incorporate the state of fuels across various areas based on the latest precipitation and soil moisture anomalies, drought, and snow depth data. While giving an overall prediction for each season, models cannot incorporate the daily weather changes that affect fire risks. The Wildland Fire Assessment System is available online from the U.S. Forest Service.

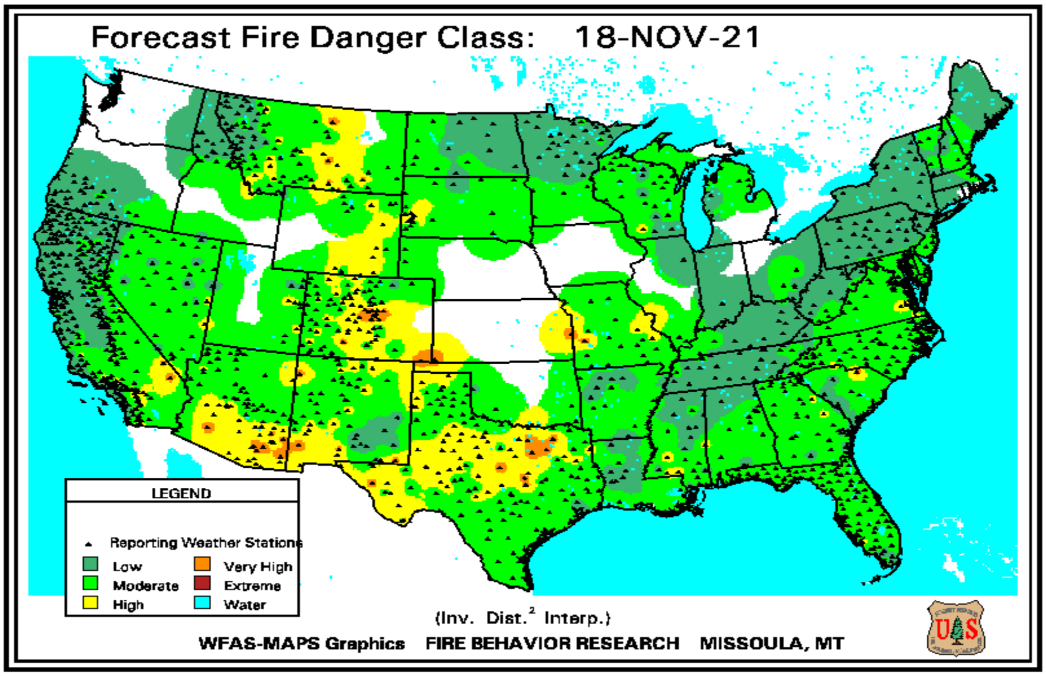


Figure 4.9.3. Wildland Fire Assessment System Model for November 18, 2021[201]

Climate change is projected to increase the frequency and intensity of extreme weather events, including severe thunderstorms that have the capability of igniting wildfires due to lightning strikes. Using global climate models and a high-resolution regional climate model, one study that investigated the link between wildfire and global warming found a net increase in the number of days with environmental conditions that foster the development of wildfires. This was true for much of the United States, including Chittenden County.[202]

Table 4.9.4. Wildfire Hazard Profile Summary

[201] Wildland Fire Assessment System; https://www.wfas.net
[202]

WILDFIRE Risk Assessment Summary: Low			Potential Cascading Effects
	Location	Jurisdiction-wide	• Power/utility outages • Traffic/roadway damage or closures • Response personnel safety • Residents' safety • Increased security • Loss of deliverable services • Redirect industry/government assets (people/equipment) • Loss of Revenue
	Extent	Mild to moderate Damage to property, turf, wildlife, urban forest	
	Duration	Several hours, to days	
	Probability	Low	
	Seasonal Pattern	Late summer and Fall	
	Speed of Onset	Slow to Rapid	
	Warning Time	Minutes to hours	
	Repetitive Loss	N/A	

4.9.2 RISK ASSESSMENT

Risk, defined as probability multiplied by impact, cannot be fully estimated for damaging wildfire events due to the lack of intensity-damage models and consistent data from the NCEI Storm Events Database or other sources. Given the low probability of wildfire in Vermont, the overall risk is considered to be relatively low. The vulnerability to wildfires is constantly changing. Predictive models for fire potential are often generated each month or season. These models incorporate the state of fuels across various areas based on the latest precipitation and soil moisture anomalies, drought, and snow depth data. While giving an overall prediction for each season, models cannot incorporate the daily weather changes that affect fire risks.

People

The severity of a wildfire on a community can be magnified to the degree the fires affect vulnerable populations, those that may require special assistance during a wildfire event, may not be able to protect themselves prior to an event, or may not be able to understand potential risks. These can include very young and elderly populations, those without transportation resources, or those in a lower socioeconomic group. Tourists and visitors to the area also have increased risk, as they are less familiar with the geography of the area and the typical means of warning residents regarding dangerous conditions.

Emergency Response

It is critical that emergency service providers have road access to burning structures in wildland areas. As development encroaches into the rural areas of the county, the number of houses without adequate turn-around space is increasing. In many areas, there is not adequate space for emergency vehicle turnarounds in single-family residential neighborhoods, causing emergency crews to have difficulty responding because they cannot access houses. Because fire trucks are large vehicles, and they are often accompanied by an ambulance and Emergency Medical Service (EMS) personnel, should immediate medical care be required, responders are impeded when a development includes narrow roads and limited access, and when there is inadequate turn-around space. In such cases, fire fighters may just be able to focus on life safety issues, such as evacuating people at risk, but they may not be able to safely remain on the scene to save the threatened structures.

Built Environment

Community Lifelines

Quantitative assessment of Community Lifelines and critical facilities for wildfire risk was not feasible for this update because insufficient data is available to identify specific facilities at risk. What is known is that construction materials, and defensible space play a role in vulnerability of structures to wildfire. In general, concrete, brick, and steel-framed structures tend to fare better in wildfires than wood-framed structures. It is important to note that not all critical facilities have redundant power sources, and structures may not be wired to allow the addition of an emergency backup generator for residential or commercial use. Future updates should consider including a more comprehensive examination of critical facilities' risk to wildfire and potential cost-effective mitigation actions.

Maintaining continuity of emergency response operations related to fire, EMS, transportation, utilities, and other infrastructure is critical to minimizing risk of people, property, the environment, and the economy.

Existing Buildings and Infrastructure Risk

The primary effects of fire – including loss of life, injury, and destruction of buildings and wildlife -- are widely known. Isolated homes with single access roads are more vulnerable to wildfires than more heavily populated areas, and the threat is increased during dry periods, especially in the late summer and fall.

There are also several secondary effects stemming from wildfire, such as a strain on public utilities, depleted water supplies, downed power lines, disrupted communication systems, and road closures. In addition, flood control facilities may be overtaxed by the increased flow of water and material from bare hillsides, including travelling debris. Affected recreation areas may need to be closed or access restricted for the safety of the general public. Moreover, buildings destroyed by fire are usually eligible for property tax reassessment, so their loss reduces revenue to local government.

Water Supply

In remote and rural areas, where wildfires typically occur, there is often a limited water supply and a lack of fire hydrants for fire fighters to tap into to access water. Rural areas are characteristically outfitted with systems that include pipes with a small diameter pipe, and these are inadequate for providing sustained firefighting flows.

Natural Environment and Economy

Communities within the planning area include natural assets vulnerable to wildfire, especially environmentally sensitive lands and those utilized for economic purposes, and recreation. Wildfires may destroy acreage that supports forest-based businesses, and damage outdoor recreational sites set up in the area's federal, state, and local parks. The region is a tourist destination for special events held outdoors, so wildfire may cause damage to areas that accommodate such festivities.

Changes in Development

The planning area's vulnerability to wildfire has remained constant overall. No significant new development has taken place, nor have older structures been removed, which would increase or decrease the probability of this hazard in the remote areas. This validates what was previously identified in the 2017 *MJAHMP*.

Hazard Risk Ranking

Each jurisdiction in the Planning Area conducted a risk analysis to consider impacts, consequences (including magnitude/severity), and probability of future occurrences to determine the Overall Risk Rating for wildfire.

Table 4.9.9: Wildfire Hazard Risk Rating Summary, All Municipalities

JURISDICTION	Sum - Impact/ Consequence Score	Probability	Total Risk Rating *(Impact/ Consequences x Probability)*	Hazard Ranking
Bolton	8	4	32	Medium
Buels Gore	6	3	18	Low
Burlington	10	4	40	High
Charlotte	3	4	12	Low
Colchester	5	3	15	Low
Essex	3	3	9	Low
Essex Junction	3	3	9	Low
Hinesburg	3	2	6	Low
Huntington	3	1	3	Low
Jericho	3	3	9	Low
Milton	3	4	12	Low
Richmond	3	4	12	Low
Shelburne	4	5	20	Medium
South Burlington	1	4	4	Low
St. George	10	3	30	Medium
Underhill	5	6	20	Medium

JURISDICTION	Sum - Impact/ Consequence Score	Probability	Total Risk Rating *(Impact/ Consequences x Probability)*	Hazard Ranking
Westford	3	3	**9**	Low
Williston	4	4	**16**	Low
Winooski	1	4	**4**	Low
AVERAGE TOTAL RISK SCORE			14.7	Low

The self-assessment compilation of jurisdiction risk scores, along with consideration of the hazard profile and potential impacts and consequences, indicates that **wildfire** is a **high-risk** hazard for one jurisdiction, and a **medium-risk** hazard for four municipalities within the Planning Area. Fourteen municipalities ranked wildfire as a low-risk hazard. Consequently, a minimal vulnerability assessment is appropriate to identify the level of exposure to the municipalities within the Planning Area.

4.9.3 VULNERABILITY ANALYSIS

Wildfires caused by human-activity and lightning present a low threat to human safety; property, including critical infrastructure; the environment; and the economy in Chittenden County.

General Exposure

The exposure to wildfire is primarily related to loss of residential structures and infrastructure, and direct economic loss if forest-based businesses are impacted; however, detailed data related to specific properties or infrastructure is not available for this plan update.

Potential Impacts of Climate Change

As the climate continues to change, the severity of storms may increase, producing more lightning, and consequently, causing more wildfires. This in turn may require more firefighting resources and hardening of vulnerable infrastructure such as power poles and utility lines.

Public Input Related to Wildfire

A Public Hazard Survey made available to the public during the planning process indicated that approximately 0.84 percent of the more than 200 survey respondent households had directly experienced wildfire within the previous five years, and most had very little concern about future wildfire events. In addition, more than 66 percent were either slightly concerned or not concerned about impacts to people, businesses, or properties from wildfire. On a ranking of the most important community assets, survey responders were most concerned about hospitals and other healthcare facilities, which have a very low threat from wildfire.

Opportunities for Mitigation

- Interface Fire Education Programs and Enforcement

Fire protection in wildland/urban interface is more effective when a landowner exercises personal initiative to take measures that protect his or her own property. Therefore, public education and awareness plays a greater role in such areas. In areas with strict fire codes, property owners who resist maintaining the minimum brush clearances can be cited for failure to clear brush.

- FIREWISE Program

The National Fire Protection Association's FIREWISE USA provides a structured program to identify individual community and property threats to wildfire and determine appropriate mitigation measures to reduce the risk. As of May 2021, no municipalities in Chittenden County participate in the program.

Factors for Consideration in the Next Planning Cycle

Future monitoring, evaluating, and updating of this plan should consider the following factors related to wildfire as well as other information from the *VT SHMP* updates:

- Have any wildfire events occurred since adoption of this plan?
- Has any new scientific research or methodology changed the ability to predict wildfire events or assess risk and vulnerability?
- Has there been any significant change in the population, built environment, community lifelines, natural environment, or economy that could affect the risk or vulnerability to wildfire?
- Is there any new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to wildfire?

Chittenden County Development Trends

The vulnerability of future buildings, infrastructure, and critical facilities is a great concern to community leaders across the county and, as discussed in the Capability Assessment section, many of the day-to-day activities in local governments in the county are designed to deal with these challenges.

Zoning is also a critical indicator to review in considering local development trends.

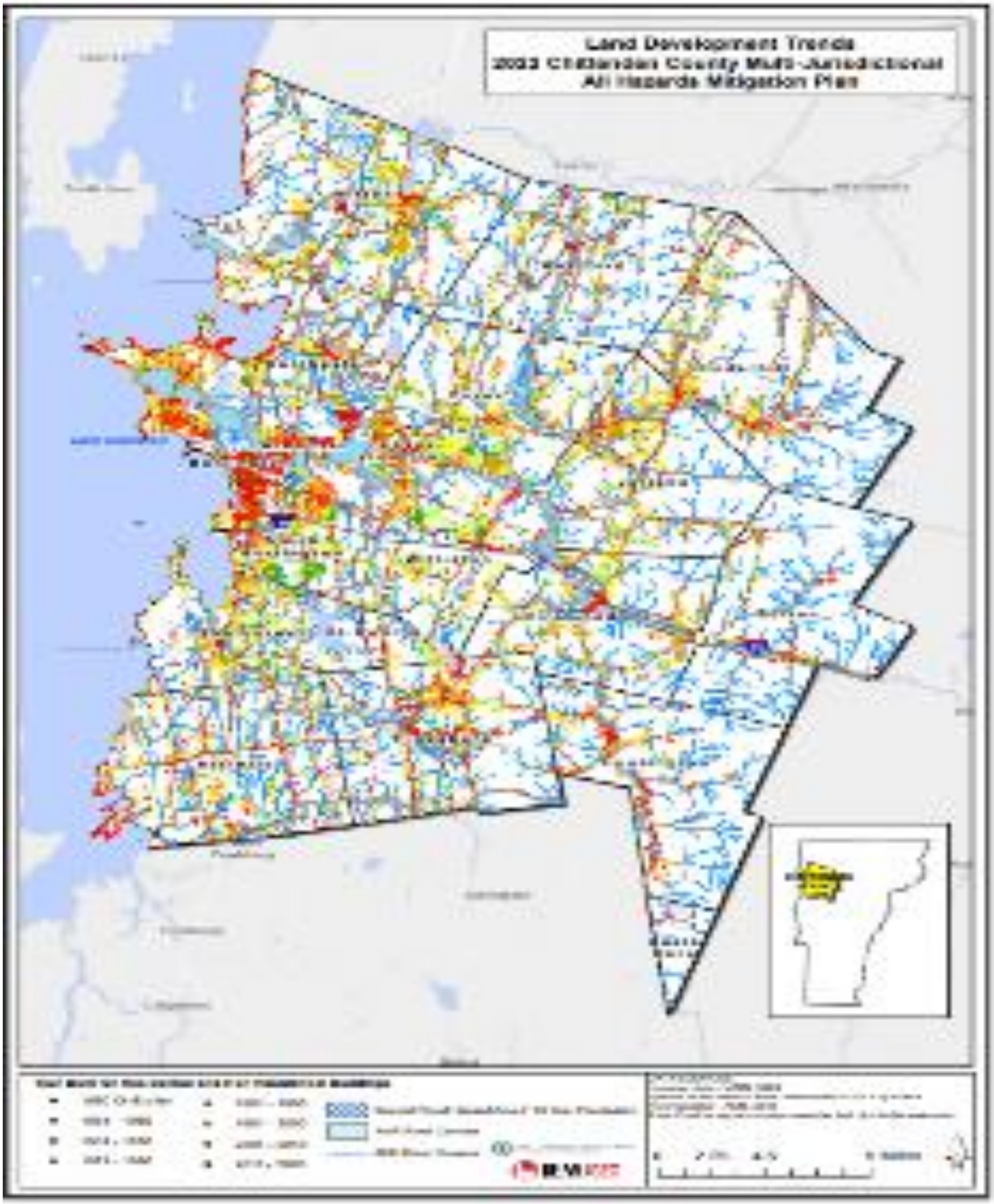


Figure 4.9.4: Land Development Trends[13]

Table 4.12: Land use compared to zoning, Chittenden County[14]

Institutional / Mass Leisure / Natural Dwelling Com/Ind Total Planning Area Residential Commercial Industrial Infrastructure Assembly Recreation Resources Units Area (ft^2)										Com/Ind Total Area (acres)
Center	2234	969	39	170	46	6	0	12443	7,155,889	164.28
Enterprise	182	750	155	62	4	1	6	266	13,237,550	303.89
Metro	18547	915	127	203	58	35	3	31493	16,559,571	380.16
Rural	14736	219	129	148	46	83	187	16684	754,385	17.32
Suburban	12618	196	64	51	37	22	6	12813	1,666,259	38.25
Village	4870	388	37	85	97	9	6	5902	1,784,825	40.973
Total:	53187	3437	561	719	288	161	208	79601	41,339,661	949.03
Data used – 2021 e911 site data was used to calculate Residential, Commercial, Industrial, Inst/Infra, Mass Assembly, Leisure/Rec and Natural Resources numbers. Dwelling Units info from CCRPC's 2020 Housing Database. Com/Ind area from CCRPC's 2020 commercial/Industrial database.										

For 2022 and beyond, new construction within the Special Flood Hazard Area (SFHA) is anticipated to be very slight to nonexistent. Fifteen of the County's 19 municipalities do not permit the addition of new structures at all; one community (Buel's Gore) includes no SFHAs while three additional communities (Burlington, Huntington and Underhill) do allow some new structures in the floodplain but only as a conditional use.

It is anticipated that some level of new units will be constructed within the River Corridor (RC) because, in some cases, the Corridor exceeds the area not covered by municipal water quality setbacks. However, in recent years the City of South Burlington and the Town of Saint George have adopted the state-recommended River Corridor Model Bylaw. The CCRPC anticipates that additional municipalities will adopt such River Corridor protections to implement strong hazard mitigation as well as to obtain a higher State match of Emergency Relief and Assessment Funds (ERAF) and preclude future development in riverine areas not covered by their own municipal water quality setbacks.

Table 4.13: Housing unit growth development, 2010 - 2020[15]

Planning Area	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Center	61	108	36	64	105	204	291	184	136	269	3
Metro	36	27	383	246	199	109	444	327	237	291	263
Suburban	72	83	145	69	98	139	122	96	120	74	109
Village	22	38	17	22	104	42	55	29	31	56	44

Planning Area	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Rural	71	78	64	66	107	93	100	93	109	86	89
Enterprise	1	0	0	1	0	0	1	1	0	0	0
Total	263	334	645	468	613	587	1013	730	633	776	508

Roads

Many people desire urban or suburban housing so as to live close to work, school and shopping. However, a significant number of people also desire more rural locations. Complicating matters is the high cost of housing, due to a shortage of both rental units and/or single-family homes in the county. This has forced many people to live in the county's outlying municipalities or even outside the county itself. A growth pattern of this nature necessitates a transportation system that supports people's mobility and a utility system that allows a certain standard of living to which people have become accustomed. Unfortunately, transportation and utility systems are vulnerable to natural disasters and any interruption is likely to have adverse effects on the health and safety of people in Chittenden County.

Flooding, fluvial erosion (including landslides) and severe rainstorm damage to roads and culverts is now more common as new access roads, driveways and subdivision roads are built in both steeper and more rural terrain and formerly quiet country roads become commuter routes. Stormwater management has become a growing concern in the county in recent years not only due to these damages but also due to non-point pollution runoff that has degraded water quality and habitat in several small streams in the county's urban and suburban areas. Nine of the County's municipalities are subject to Municipal Separate Storm Sewer System permits issued by the Vermont Department of Environmental Conservation (DEC). Additionally, with the passage of the Vermont Clean Water Act in 2015 and its attendant requirement for implementation of Municipal Roads General Permit, the remaining municipalities in the County (with the exception of Buel's Gore) have had to begin a systematic implementation of various projects to slow erosion and flow off roads.

Transportation infrastructure, not homes and businesses, are the most commonly threatened and damaged property in the County. This is especially true when it comes to unpaved roads. In general, the outlying and higher elevation municipalities have the highest percentages, but even some of the more rapidly developing mixed rural/suburban municipalities have significant amounts of unpaved roads.

The Vermont Agency of Transportation divides municipal (town) highways into various classes of roads:

- Class 1 town highways are state highways in which a municipality has assumed responsibility for most of the day-to-day maintenance (pothole patching, crack filling, etc.). The state is still responsible for scheduled surface maintenance or resurfacing. In Chittenden County Class 1 highways are generally paved.

- Class 2 town highways are primarily the responsibility of the municipality. The state is responsible for center line pavement markings if the municipality notifies VTrans of the need. The municipality designates highways as Class 2 with approval from VTrans. These are, generally speaking, the busier roads in each town second to Class 1. In Chittenden County, most Class 2 highways are generally paved although in the more isolated areas these are gravel roads.
- Class 3 town highways are the responsibility of and designated by the municipality. These are to be maintained to an acceptable standard and open to travel during all seasons. In Chittenden County, Class 3 roads are both paved or gravel.
- Class 4 town highways are all other highways and the responsibility of the municipality. However, pursuant to Vermont State Statutes, municipalities are not responsible for maintenance of Class 4 town highways. These are generally closed during the winter and minimally maintained and almost exclusively dirt.

Table 4.14: Municipal Highway Paved and Unpaved Road Mileage, Chittenden County[203]

Class 1	Class 2	Class 3	Class 4	Federal Highway & Interstate	State Highway	Total Class 1, 2, 3 & Highway
16.409	287.53	719.85	37.83	N/A	174.506	1198.295
Paved	Gravel	Soil/Graded	Unimproved	Impassable	Unknown	Total
906	262	46	7	15	N/A	1,236
Total Known	Total Paved	% Paved	% Unpaved			
1236	330	78%	22%			

From a damage mitigation standpoint, the county is fortunate that most of its municipalities' roadways are paved (78%) and very little (22%) is soil/graded or unimproved. More than 50 percent of the roads in Hinesburg (53.7%), Huntington (73.9%), Underhill (67.7%), Westford (76.6%), and Williston (87.6%) are listed as unpaved.

Table 4.15: Municipal highway paved and unpaved road mileage by Jurisdiction: Chittenden County[204]

Jurisdiction	Unpaved	% Unpaved		Paved	% Paved	Total Known
Bolton	11	34.4%		21	65.6%	32

[203] Source: Publications | Agency of Transportation (vermont.gov)
[204] Ibid.

Jurisdiction	Unpaved	% Unpaved	Paved	% Paved	Total Known
Buels Gore	-	-	3	100%	3
Burlington	1		95		95
Charlotte	34	42%	47	58%	81
Colchester	14	12%	103	88%	117
Essex	25	43.8	32	56.1	57
Essex Junction	1	2.2%	45	98.8%	46
Hinesburg	36	53.7	30	44.8	67
Huntington	34	73.9%	12%	26.1	46
Jericho	33/2		30/7		63/9
Milton	17/1		81/27		97/28
Richmond	25	38.5%	40	61.5%	65
St. George	1	16.7	4	66.7	6
Shelburne	2	3.4%	57	96.4%	59
South Burlington	1	2%	98	98%	100
Underhill	44	68.7%	20	31.3%	64
Westford	38	76%	12	24%	50
Williston	85	87.6%	12	12.4%	97
Winooski	-	-	19	11%	19

As noted in the 2017 Plan, some of the highest damage totals suffered in the county were to gravel and dirt roads and culverts due to the inability of this type of infrastructure to handle large volumes of snowmelt, stormwater runoff, rising stream waters, or the sediment and debris that comes with them. More urban municipalities, by contrast, suffered only minor damage from such flooding. However, it would be simplistic to argue that paving gravel roads in the outlying municipalities by itself would adequately mitigate against the effects of future flooding. Paving programs must also be combined with systematic upgrading of culverts and other measures to adequately handle excessive water volumes. In some cases, upgrading gravel road construction, culverts, and drainage may be preferable to paving.

SECTION 4.10: TECHNOLOGICAL HAZARDS

The following discussion on technological hazards is based upon information from several sources. General descriptions are based upon the *2013 Chittenden County Regional Plan,* Chittenden County Regional Planning Commission (CCRPC), and information from private utility companies. Additional information from the 2017 MJAHMP is still relevant and is included in this update.

This Plan profiles several Technological Hazards. Prior to this discussion of technological hazards and the subsequent analysis of risk and vulnerability, it is first helpful to summarize the general state of knowledge regarding Location, Extent and Impact in Chittenden County for these hazards, as presented in this section.

Table 4.10.1: Technological Hazard Profile Summaries

Hazard	Is Location data available?	Are Extent data available?	Is Impact data available?
Water Pollution	Impaired streams that lack adequate biota are identified.	Phosphorus-loading for general locations is known but non-point sources (agricultural lands, developed lands, forests, etc.) are varied and dispersed	Annual budgetary impacts to individual municipalities are significant but vary depending upon location.
Hazardous Materials Incident	Storage locations are known. Incidents occurring during transportation could occur anywhere.	Rough estimates of spill amounts are recorded.	No formal readily available on cleanup costs.
Power Loss	Outage locations not mapped	During an actual outage some data is recorded on duration.	Outage data is broad and refers to total customers within a county.
Multi-Structure Fire	Could happen anywhere	Data not formally collated across agencies	Data not formally collated across agencies
Major Transportation Incident	Depending upon type of incident, could happen anywhere	No formal database of damages.	Varies depending upon type of incident.

Hazard	Is Location data available?	Are Extent data available?	Is Impact data available?
Water Supply Loss	Water distribution systems are mapped	Data not formally collated across agencies	Data not formally collated across agencies
Sewer Service Loss	Sewer lines are mapped	Data not formally collated across agencies	Data not formally collated across agencies
Natural Gas Service Loss	General areas of services are known but specific locations of loss not recorded	Information for this rare occurrence not publicly available.	No formal damage has been documented to date.
Telecommunications Failure	Depending upon type of incident, could happen anywhere	Information for this rare occurrence not publicly available.	No formal damage has been documented to date
Other Fuel Service Loss	Distribution points are individual addresses	No formal loss of service has been documented.	No formal damage has been documented to date

Water Pollution

The CCRPC and participating municipalities decided to profile Water Pollution to encapsulate a growing hazard to water quality in the County. This hazard is included in order to:

- Capture the threat posed to the water quality of Lake Champlain from increased levels of phosphorus.
- Capture the long-standing impacts of excess stormwater on local streams.
- Capture the existing and growing regulatory and financial burden on Chittenden County municipalities to comply with state and federal laws regarding water quality.

Finally, this hazard, as defined in this Plan, is distinct from the hazard of a fuel or chemical spill into water, which is more appropriately considered a Hazardous Materials Incident.

Lake Champlain is a cornerstone of the county's economy by drawing commerce and visitors to the region. Water pollution can pose a threat to the health, economic well-being, and overall quality of life of the region's residents. Water resources often cross town, county, state, and national borders. A watershed's water quality can only be protected or enhanced through the cooperation of the municipalities and landowners that live, work, and play in the watershed. Residents, municipalities and businesses are also concerned about the health and economic impacts of occurrences of algal blooms in Lake Champlain. Blue-green algae blooms occur in Lake Champlain in the summer as a result of overabundant phosphorous in the water. In some cases, neurotoxins in the algae blooms have caused health problems and beach closures. If such blooms become a daily or weekly problem along the lakeshore communities, this could ultimately affect resident and visitor perceptions of the ecological health of the lake ecosystem. If not addressed this could lead to reduced tourism traffic and reduced property values.

The regulatory and policy framework dealing with Water Pollution has taken an interesting turn with the passage of the Vermont Clean Water Act in 2015. The following descriptions of this framework are excerpted from Chapter 1 of the most recent Lamoille Tactical Basin Plan adopted by the Vermont Department of Environmental Conservation in December 2016.

Tactical Basin Plans (TBP), Water Quality Standards and the Vermont Clean Water Act.

A. Tactical Basin Planning Process
Tactical basin plans (TBPs) are developed according to the goals and objectives of the Vermont Surface Water Management Strategy to protect, maintain, enhance, and restore the biological, chemical, and physical integrity, and public use and enjoyment of Vermont's water resources, and to protect public health and safety. The tactical basin planning process allows for the completion of tactical basin plans for all of Vermont's fifteen basins every five years, as required by statute. The streamlined process for issuing tactical basin plans facilitates targeting strategies and prioritization of resources to those projects that will have the greatest impact on surface water protection or remediation.

B. Vermont Water Quality Standards
The Vermont Water Quality Standards (VWQS) define biological integrity as "the ability of a body of water to support and maintain a community of organisms that has the expected species composition, diversity, and functional organization comparable to that of the water in its natural condition." The health of a biological community is a reflection of the level of combined human-induced stresses acting upon it. Aquatic communities that are most impaired suffer from an accumulation of multiple stressors.

As a follow-up to the 1972 Federal Clean Water Act, which requires states "to restore and maintain the chemical, physical and biological integrity of the nation's waters.", the VWQS are rules ***specific to Vermont*** *that protect the waters of the state. The implementation actions identified in the TBPs are meant to fulfill all of the geographically-specific planning requirements in the VWQS, while the statewide planning requirements, including state-scale strategies, are addressed in the statewide Surface Water Management Strategy.*

C. The Vermont Clean Water Act
In 2015 the Vermont Legislature passed Act 64, the Vermont Clean Water Act. This Act strengthens multiple statutes related to water quality in the State. The Act addresses agricultural water quality on small, medium, and large farms through the Agency of

Agriculture, Food and Markets. It establishes water quality requirements for stormwater discharges from new and existing development, industrial and municipal stormwater discharges, and runoff from municipal roads through the Department of Environmental Conservation (VDEC). Through the Department of Forests, Parks and Recreation and VDEC, the Act addresses water quality runoff from forest silvicultural activities and supports wetland restoration efforts within the Lake Champlain Basin. Regulations specific to these new requirements are covered in detail in the final VT Lake Champlain Phosphorus Total Maximum Daily Load (TMDL) Phase I Implementation Plan

The Act also establishes the requirement that all water quality improvement actions undertaken by the State be integrated by means of TBPs, and establishes partnerships with Regional Planning Commissions, Conservation Districts, and other organizations to support this work. Regarding work with the Regional Planning Commissions, the Agency of Natural Resources (Agency) will work with the applicable regional planning commissions to develop an analysis and formal recommendation on conformance with the goals and objectives of applicable regional plans, see 10 V.S.A 1253(d)(2)(G). The overall role of the TBPs is not to determine where development should happen. This TBP encourages communities to take protective measures that will restore, maintain and enhance water quality in all areas, and does not preclude any development that is consistent with municipal zoning, regional and municipal plans, and with applicable state and federal regulations.

Lake Champlain and Phosphorus

The Lake Champlain Phosphorus Total Maximum Daily Load (LC TMDL) establishes the allowable phosphorus loadings, or allocations, from the watershed for the lake water quality to meet established standards. These allocations represent phosphorus loading reductions that are apportioned both by land use sector (developed land, agriculture, etc.) and by lake watershed basin (Lamoille, Missisquoi, etc.). Due to the large size of the Lake Champlain watershed in Vermont, the modeling techniques used to estimate loading were implemented at a coarse scale. For example, the modeled loading at the mouth of the major river basins is based on monitoring data and represents the collective inputs from the various land uses and physical features of the watershed. On the whole, this is useful to estimate the necessary level of phosphorus reducing Best Management Practices (BMPs). However, when looking at smaller scale areas such as a municipality, a particular farm or a local road network, it's necessary to complete a detailed on-the-ground analysis to determine appropriate actions for the particular area.

As part of the LC TMDL development, EPA developed a "Reasonable Assurance" analysis at the major-basin scale to determine if it was theoretically possible to obtain to necessary phosphorus reductions. By using modeling results for the entire Champlain Basin, the TMDL was able to show that through a concerted effort across all phosphorus sources, it appeared possible to reach the lake loading targets with appropriate *application of BMPs. However, since this exercise was conducted at the major-basin scale, there is no specific prescription as to where BMPs should be applied. It is through the development of the Tactical Basin Plans those more precise opportunities for BMPs can be identified and prioritized for implementation.*

The LC TMDL will be implemented through a series of permit programs as well as identification of site specific BMPs outside the scope of specific programs, many guided by the content of the Tactical Basin Plans. While many programs will be "self-implementing", in many instances, application will proceed in a two-step process of first knowing "where to look" for opportunities followed secondly by "what to do". Many of the phosphorus reduction programs require an initial "assessment" phase to identify what BMPs may already exist on the landscape and where others need to be placed. In some instances, the Tactical Basin Plans can aid prioritization areas of "where to look" first such as expected high phosphorus producing areas. After the assessment phase, BMP implementation can be prioritized and carried forward. Additionally, the Tactical Basin Plans can identify known beneficial projects, the "what to do", prioritize them for funding so that implementation can be expedited, and also tracked transparently.

The LC TMDL also incorporates an "Accountability Framework" that aims to ensure that phosphorus reduction actions are being implemented at a sufficient pace to see results in the lake. While the specific timeline for lake improvement isn't specified by the TMDL, an estimate of the predicted phosphorus reduction needs to be identified within each Tactical Basin Plan on a 5-year rotating basis. Estimating the potential phosphorus reductions expected from site specific actions is one way of determining if the level of effort is sufficient compared to the overall TMDL goals. This portion of the Tactical Basin Plan attempts to provide that estimate of phosphorus reduction reasonably expected from actions taken in specific areas across the basin, specific to source types and regulatory program.

In conjunction with Tactical Basin Planning is a project implementation tracking system that VDEC is also developing. This system intends to track implementation of projects across all sectors and apply an expected phosphorus reduction estimate to each. Over time, as projects are continually implemented, a more precise estimate of cumulative ***actual*** *phosphorus reductions can be reported rather than relying on estimates of* ***potential*** *actions.*

Tactical Basin Plans are the primary tool to identify needed actions with regard to overall water quality. In general, as seen in the December 2016 approval of the Lamoille Tactical Basin Plan, these actions fall into the following types:

- Address agricultural stressors.
- Address stormwater issues.
- Encourage stream equilibrium and wetland and river corridor protection.

- Address invasive species.
- Address lake and pond shoreland and lake habitat condition.
- Address impaired waters, landfills, or hazardous waste sites.
- Address flow altered waters, waters for public water source reclassification.
- Protection and evaluation for ORW [Outstanding Resource Waters] and reclassification.
- Address forests and water quality.
- Support recreational uses.

This hazard mitigation plan seeks to incorporate the principle outlined in the Vermont Clean Water Act that *"all water quality improvement actions undertaken by the State be integrated by means of TBPs, and establishes partnerships with Regional Planning Commissions, Conservation Districts, and other organizations to support this work."*

Addressing Phosphorus Runoff from Developed Lands

In the LC TMDLs, all permissible developed land phosphorus loads are considered part of the wasteland allocation. As such, this section describes the four regulatory programs identified to address phosphorus and other impairment pollutant discharges from developed lands. They are the: Transportation Separate Storm Sewer System Permit (TS4); Municipal Roads General Permit (MRGP); Municipal Separate Storm Sewer Permit; and, the so-called Operational Three-acre Impervious Surface Permit.

Phosphorus Loading from Roads

Currently, TP loading estimates for roads only exist from the SWAT model which distinguishes only between paved and unpaved roads. Unfortunately, two of the primary phosphorus reduction regulatory programs related to roads, the MRGP and the TS4, are defined by more narrow parameters than just paved and unpaved. For example, the MRGP will apply to municipally managed roads, and require applicable practices to be applied to all roads that are "hydrologically-connected" to waterbodies, while the TS4 permit will only apply to state-managed roads.

Municipally Managed Roads (Municipal Roads General Permit)

The Municipal Roads General Permit is a new stormwater permit for all Vermont cities and towns that is intended to achieve significant reductions in stormwater-related erosion from municipal roads, both paved and unpaved. The permit will require each municipality to develop a road stormwater management plan to bring road drainage systems up to basic maintenance standards to stabilize conveyances and reduce erosion. The road management plan will require an inventory of municipal roads and current conditions, an identification of potential road best management practices (BMPs), and a prioritized implementation schedule to achieve the road standards. Implementation of the Municipal Roads General Permit by each municipality is estimated to achieve the 20.5% reduction of TP from the developed lands within the municipality.

DEC developed remote sensing information for municipalities to initially identify hydrologically connected road segments that have the potential to be at risk of erosion and may be a source of sediment and phosphorus pollution to surface waters. This estimated mileage, along with more detailed town maps, will help municipalities establish initial town road inventories and prioritize improvements.

Municipally Separate Storm Sewer Systems (MS4)

The Municipal Separate Storm Sewer System permit is a permit for municipalities with census designated urbanized areas and stormwater impaired watersheds. Under the MS4 permit, those designated municipalities will be required to develop a comprehensive phosphorus control plans (PCP) to achieve the percent phosphorus reduction for their respective lake segment, on all developed land within the municipality. These municipalities will not need separate permit coverage under the Municipal Road Permit or the "3-acre designation," as these requirements will be incorporated into the phosphorus control planning within the municipality. The PCPs will include requirements to inventory all developed land within the municipality, estimate phosphorus loading from developed land, and identify BMPs and an implementation schedule to achieve the required reductions

As defined by the Environmental Protection Agency, a municipal separate storm sewer system:

"… is a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or a designated and approved management agency under Section 208 of the CWA that discharges to waters of the State and waters of the United States….Designed or used for collecting or conveying stormwater; Which is not a combined sewer; and Which is not part of a publicly owned treatment works."

In Chittenden County, there are nine municipalities and three organizations that must have an MS-4 permit. These twelve permitees are considered "small MS-4s" and are automatically designated as follows: *Automatic designation - Small MS4s located within the boundaries of a Census Bureau-defined Urbanized Area (UA) based on the 2000 Census or any subsequent decennial census. Urbanized Areas include areas with populations of at least 50,000 people with an overall population density of at least 1,000 people per square mile. These communities are <u>Burlington, Colchester, Essex, Essex Junction, Milton, Shelburne, South Burlington, Williston, and Winooski</u> (emphasis added). Three publicly owned 'non-traditional' separate storm sewer systems were also designated. These systems are owned or operated by the University of Vermont, Burlington International Airport and the Vermont Agency of Transportation. The* *regulations apply to areas served by each MS4 that are located either within the UA or watersheds that are principally impaired by stormwater.*

Since their designation in 2003, these nine municipalities as well as the three other entities typically spend millions of dollars on an annual basis combined to comply with their permit and annual expenditures in this area are expected to grow to meet requirements. These permitees must annually implement six minimum measures: (1) Public Education and Outreach, (2) Public Participation/Involvement, (3) Illicit Discharge Detection and Elimination, (4) Construction Site Runoff Control, (5) Post-Construction Runoff Control, and (6) Pollution Prevention/Good Housekeeping. Starting in October 2016, all of these municipalities (except for Milton) began to implement Flow Restoration Plans (FRP) over the next twenty years for their portion of each stormwater impaired watershed in their community. Additionally, starting in mid-2021, all of these MS4s filed required Phosphorus Control Plans with DEC as well detailing how they will treat and manage stormwater from municipal roads and municipal properties.

Hazardous Materials Incident

Hazardous Material Storage and Release

A major Superfund Amendments and Reauthorization Act (SARA) provision is Title III, also referred to as SARA Title III or the Emergency Planning and Community Right-to-Know Act (EPCRA). EPCRA establishes guidelines for Federal, State and local governments and industry regarding emergency planning and providing communities with information on hazardous chemicals within their jurisdiction. The State of Vermont's implementation of its SARA requirements was approved by the Legislature in 1994. Chittenden County was designated as an emergency planning district and Vermont Emergency Management established a Local Emergency Planning Committee, known as LEPC #1, for the county[205]. The function of the LEPC is to carry out duties proscribed in SARA Title III. In addition, Vermont statute dictates that the LEPC shall insure that the local emergency response plan has been implemented upon notification of a release of hazardous chemical or substance, consult and coordinate with municipal emergency service providers, Vermont Emergency Management, and the managers of all HAZMAT facilities within Chittenden County regarding the facility plan, and review and evaluate requests for funding. Farmers are not required to report agricultural chemicals stored on their properties, but they do not typically store and keep large amounts of these chemicals. Individual locations using and storing EHS and/or petroleum products are identified in each municipal annex.

Hazardous materials are categorized according to nine nationally standardized categories (Explosives; Gases; Flammable liquids and combustible liquids; Flammable Solids-Spontaneously combustible materials-Dangerous when wet w materials; Oxidizers and Organic

[205] As of the 2022 MHAHMP update, the LEPC #1 has been integrated in Vermont's single state-wide Local Emergency Planning Committee.

peroxides; Toxic Materials and infectious substances; Radioactive Materials; Corrosive Materials, and Miscellaneous Dangerous Goods. Past data from 2000-2008 summarized in the 2011 MJAHMP showed that of the 458 recorded releases indicated that 245 of these were classified as flammable liquids and combustible liquids while 144 releases were unclassed. Updated data related to more recent incidents and types of releases was not available during the preparation of this update.

However, a closer review of previous data showed that the location of the spills by municipality contained some inaccuracies and the amounts spilled were recorded in different units. This data showed that nearly all such hazardous materials spill incidents consisted of accidental discharges of gasoline, diesel or fuel oil when customers or delivery personnel were pumping these products. The majority of spills were in quantities of less than five gallons.

In September 2008, a warehouse at the Saputo Cheese Factory in Hinesburg caught fire. Hazardous cleaning chemicals stored at the site, including sodium hydroxide, became airborne and caused half a million dollars' worth of damage to firefighting equipment. The incident raised awareness and concern among county emergency responders regarding Hazmat capabilities. With regards to radiological hazards, small amounts of radioactive material are stored at individual medical and research facilities in Chittenden County.

Hazardous Waste Sites

A significant potential for severe pollution impacts to water and ecosystems exists from hazardous waste sites. The future likelihood of such an event, however, is unquantifiable. As of February 2021, there were approximately 328 hazardous waste locations in Chittenden County, according to a database maintained by Vermont Agency of Natural Resources (ANR). This represents an increase of 78 new sites since the 2011 plan update. The greatest increase in the number of sites occurred in the City of Burlington, with from 70 to 142 sites, while the Town of Shelburne had the greatest decrease in sites from 13 to 7. These sites are areas where groundwater or soil contamination from sources such as underground fuel storage tanks have been identified. Many of the sites have been cleaned up. Others are at the assessment stage or are awaiting funding for cleanup. This list includes only sites that have been voluntarily reported to the state; other unknown hazardous waste sites may exist.

Table 4.10.2 Active hazardous waste sites, Chittenden County, February 2021[206]

Municipality	*2016 Hazardous Waste Sites*	*2021 Hazardous Waste Sites*
Bolton	3	2
Buels Gore	0	0
Burlington	70	142

[206] Vermont Agency of Natural Resources, Waste Management Division, http://www.anrweb.vt.gov/DEC/ERT/Hazsites.aspx

Municipality	2016 Hazardous Waste Sites	2021 Hazardous Waste Sites
Charlotte	10	6
Colchester	22	22
Essex/Essex Jct.	20	36
Hinesburg	9	6
Huntington	4	3
Jericho	5	3
Milton	14	14
Richmond	4	5
Shelburne	13	7
South Burlington	46-5	45
St. George	0	0
Underhill	2	3
Westford	1	2
Williston	18	17
Winooski	9	15
TOTAL	**250**	**328**

Two of the above locations are EPA-designated Superfund sites. One, located at an industrial site on Commerce St. in Williston, is contaminated with heavy metals and industrial solvents, which have resulted in water and air quality problems at nearby residences. The groundwater contamination has the potential to affect the water supplies of over 1,500 people living within four miles. The other Superfund site, the Pine St. Barge Canal in Burlington, was the site of an early 20th century gas works, and is contaminated with hydrocarbons, volatile organic compounds, and heavy metals. The water at this site drains directly into nearby Lake Champlain. Numerous businesses and residences are located within one mile of the site. The other hazardous waste sites in the county are smaller in scale and severity.

The U.S. Coast Guard Station in Burlington maintains data on fuel spills in Lake Champlain to which it has responded. In 2002 they assisted one small pleasure boat that was leaking gas. In 2003 they responded to a 200–300-gallon fuel oil spill near St. Albans in Franklin County, Vermont that was then assisted by the local fire department. That same year, a marine fuel gas spill of approximately 10 gallons occurred at the Shelburne Shipyard that was then responded to by the Shelburne Volunteer Fire Department, HAZMAT Team. In summer 2008, a small craft sank in Burlington harbor and leaked fuel. In summer 2009, a Vermont Air National Guard aircraft dropped a fuel tank into the lake.

Military Ordnances

Several military facilities are located in Chittenden County, operated by the Vermont National Guard, the Army Reserve, and the Coast Guard. As part of military operations, military ordnance is stored within the county. The ordnance is considered well secured and is regularly inspected. Potential exists for an ordnance incident, but the Vermont National Guard has Explosive Ordnance Disposal teams equipped to deal with the ordnance stored in the county. These teams also have mutual aid agreements with emergency officials in the surrounding municipalities that could be called upon in the case of an incident. Note that concerns about the potential discharge of ordnance in connection with the operation of aircraft operating from the Vermont Air National Guard base in South Burlington are discussed in specific Local All-Hazards Mitigation Plans annexed to this MJAHMP.

Loss of Services

Power Services

Electrical services in the City of Burlington are provided by the Burlington Electric Department. Green Mountain Power Corporation provides electrical distribution services for most of the remaining municipalities with the exception of certain sections of Milton, Westford, Underhill and Jericho, which are served by Central Vermont Public Service Corporation. (Vermont Electric Co-op based in Johnson also has service territory in Chittenden County*).* Service outages are a common problem in the eastern portions of Chittenden County due to the greater frequency of high winds, heavy snow, and lightning strikes, though most such outages are under two hours in duration.

The most significant disruptions to electrical services are events which cause outages lasting more than a day and those which affect a wide area. This was the case during the January 1998 ice storm and some severe storms in 2003. While it is fortunate that no major high voltage electric transmission lines came down in Chittenden County during the 1998 Ice Storm, these did come down dramatically in other parts of the northeast and Canada.

While there are some power generation facilities in Chittenden County, the county is largely reliant on electricity generated elsewhere in Vermont or out of state. The failure or incapacitation of any of the high-voltage transmission lines that carry electricity into and through the county could cause a significant outage.

Peak electricity use has been on the rise in Chittenden County, especially in summer. This strain on the transmission system could result in brownouts or power outages. Due to the low energy production in the county, up to 90 percent of northwest Vermont's electricity at summer peak times comes through the VELCO (Vermont Electric Power Company) Transmission System. Since 2003, VELCO has been working on upgrading its transmission system from Rutland to Burlington as part of the Northwest Reliability Project. Along with the upgrade of the transmissions system, efforts are being made in the county to reduce peak electricity use through energy efficiency measures. It is worth noting that temporary Power Loss is often a consequence of Severe Winter Storms and occasionally of Severe Rainstorms.

Water Services

In 2016, Chittenden County's current public water services supply water to over 135,000 people. The Champlain Water District (CWD) is the county's largest water supplier, serving 75,000 people with a total of 25,000 metered connections within CWD's twelve served municipal water system's 70 square mile county service area. The CWD is a municipally chartered, consolidated water district, serving South Burlington, Shelburne, Williston, Essex Town, Village of Essex Junction, Winooski, Colchester Town, Colchester Fire District #1, Colchester Fire District #3, Milton, Village of Jericho, and the Mallets Bay Water Company.

The Burlington Department of Public Works (BPW) serves more than 40,000 people with about 10,000 connections within the City of Burlington and Colchester Fire District #2. Lake Champlain is the source for both the CWD and the BPW water systems. Additional municipal water systems provide water service in Jericho, Underhill, Richmond, and Hinesburg, each serving about 300 connections.

Loss of water service to several customers or users at one time is a generally rare occurrence; however, loss of water service in even a small area could affect firefighting capabilities, so the issue is of concern to local officials. During extreme cold, some customers are occasionally without service for several hours if the cold causes a pipe to burst (see discussion in Section 4.3 concerning Extreme Temperatures). Outside of the CWD and municipal water systems, residents and businesses obtain water through individual wells or through a community well, which serves a small cluster of users. Well-users in certain discrete locations in the county suffer occasional water shortages due to a low water table. Users may contract with water haulers or a municipality may ask the National Guard to provide "water buffalo" tankers to replenish individual wells during these spot droughts.

Sewer Services

There are 12 wastewater treatment facilities serving South Burlington, Colchester Town, Colchester Fire District #1, Burlington, Williston, Essex Town, Village of Essex Junction, Winooski, Hinesburg, Milton, Richmond, and Shelburne. These facilities have a permitted collective capacity to treat 20.32 million gallons per day of discharge and have an average annual flow 9.56 million/gallons/day. As of 2016, together these facilities provide wastewater treatment to approximately several thousand connections encompassing residential, commercial, industrial and institutional uses.

Locations outside of sewer service areas rely on individual septic systems to treat wastewater. Some newer, rural subdivisions use a community septic system. Loss of sewer service to several customers or users at one time is a rare occurrence throughout the county. The location of sewer service areas are shown in the individual municipal annexes.

Gas Service

Vermont Gas Systems (VGS) provides piped, natural gas service to more than 50,000 residential and commercial customers in Chittenden County and Franklin County, with Chittenden County having the majority of customers. Gas supplies originate in Canada, are brought south from Franklin County through transmission lines and then, (after passing through measuring and regulating stations where the pressure is reduced) are fed through distribution lines buried immediately to the side of the road. Service areas in Chittenden County presently include most of Burlington, South Burlington, Winooski and Essex Junction and significant portions of Milton, Colchester, Essex, Williston and Shelburne. Underhill, Hinesburg, Richmond and Jericho also have some gas service, though not in a wide area. Loss of gas service is a rare occurrence in Chittenden County. Most losses of service typically only impact a few homes or businesses.

Telecommunications System Failure

Land-line telecommunications services in Chittenden County are largely provided by FairPoint Communications, Waitsfield/Champlain Valley Telecommunications, and Burlington Telecom. Collectively, these companies are responsible for operation, maintenance and repair of telecommunications facilities. Service outages are a common problem in the eastern portions of Chittenden County due to the greater frequency of high winds, heavy snow and lightning strikes. Distribution of phone lines generally follows the same corridor as roads. Weather or other problems interrupting services outside of Chittenden County or even outside the state of Vermont have the potential to disrupt service in the County. Service outages that affect emergency communications are of concern to local officials. Several providers of cellular phone service operate in the County. Due to the varying terrain in the County, there are several locations in the County where it can be difficult for a user to obtain a signal.

Also of concern to some county officials is the prospect of a computer virus that could propagate and shut down computer systems, public and private, across the county. The likelihood of such an occurrence has not been evaluated; however, and there is no reason to believe that Chittenden County is any more vulnerable to such a problem than any other place in the state or country.

Fuel Services

With regard to sources of building heat, prior versions of this Plan before 2017 only referenced Natural Gas Service. The AHMPUC felt it appropriate to also list other sources of such as Heating Oil, Propane and Wood. Heating oil, usually in the form of #2 diesel and kerosene, is the most commonly used of these services as this, along with coal, was the fuel of choice prior to the development of natural gas. Many homes and businesses within the geographic area served by Vermont Gas still use heating oil to power furnaces as do most homes and businesses not served by Vermont Gas. Use of firewood for home heating, along with wood pellet stoves, is very common throughout the county, especially rural areas. Many homes in all areas of the county often use both furnaces and woodstoves interchangeably. Propane is used in some rural areas mostly as a means to provide fuel for gas stoves. Most losses of services for these fuels typically only impact one home or business at a time primarily due to human error or financial difficulties that allow existing supplies to run out before the next delivery.

Multi-Structure Fire

According to the *2018 Vermont State All-Hazards Mitigation Plan*,

> *Vermont has one of the highest per capita death rates from fire in the nation. This is the deadliest form of disaster throughout the state. In 2000, there were 831 structural fires in the state, 12 of which resulted in 22 civilian deaths. 20 of those deaths occurred at residences. Although there have been requirements for smoke detectors in rental housing for over 20 years, and requirements for smoke detectors in single family dwellings since 1994, only one building involved in the fatal fires in 2000 had working smoke alarms. For some remote locations, access to water for emergency vehicles has been a factor in controlling an outbreak of fire.*

The Fire Marshal's Report of **2019 Crime Rates per Capita, Chittenden County** estimated property loss of over $17.89 million dollars a year due to 2,678 reported fires statewide. Of concern to the more urbanized portions of Chittenden County are multi-structure fires that destroy multiple homes and businesses, even entire downtown areas. No town in the county has lost a significant portion (at least several blocks) of its downtown area to fire.

In describing major fire events, only the frequency of multi-structure fires was considered. The *2018 Vermont State All-Hazards Mitigation Plan* states that: *"Even in their village or downtown areas, most lot sizes are at least an acre in size, which limits the likelihood of a multi-structure fire. The municipalities where there is a theoretical likelihood of a significant multi-structure fire are those communities with denser urban residential or mixed-use areas, large apartment buildings, condominiums, or small lot mobile home parks."* Many of the county's municipalities are at reduced risk for this type of event, as their population is mostly dispersed in single-family homes in rural areas.

Table 4.10.3: State of Vermont's Fire Marshal's Report for 2020 and Current Public Protection Class ISO Rating for Fire Departments Operating in Chittenden County.[207]

Dept.	ISO Rating (Year if known)	Service Good Intent	False Alarm	Hazardous Condition	Structural Fire	Total Calls
Bolton	7/9	36	7	16	22	101
Burlington	**3 (2014)**	1433	1169	149s	116	7548
Charlotte	9	2	14	10	2	42
Colchester Center	**4 (2012)**	93	143	37	32	527
Mallets Bay (Colchester)	5	65	59	20	19	265
Essex	5/9	81	99	51	32	583

[207] State of VT Report of the Fire Marshal; http://firesafety.vermont.gov/

Dept.	ISO Rating (Year if known)	Service Good Intent	False Alarm	Hazardous Condition	Structural Fire	Total Calls
Essex Junction	4	107	82	55	17	394
IBM (Essex Junction)		0	0	0	1	1
Hinesburg	**6/9 (1998)**	40	37	11	21	430
Huntington	**9/10**	2	3	10	5	24
Milton	5/9	34	13	64	2	180
Richmond	**6/9/10**	26	16	28	31	154
Shelburne	**6/6x (2014)**	36	86	25	18	211
S. Burlington	**3 (2013)**	633	321	291	9	3508
Underhill-Jericho	**4/6/10 (2014)**	50	30	9	16	439
Westford	9/10	7	3	7	6	34
Williston	**3/3Y**	423	3	33	37	1905
Winooski	**4 (2016)**	74	85	26	60	289
TOTAL						
Buels Gore		*No data available. Service provided by Starksboro Fire Dept.*				
Saint George	9	*Service provided by Hinesburg Fire Dept.*				
Vermont TOTAL						

Notes: Total Calls also include incidents classified as "cancelled, wildland, other, vehicle, outside, other fire, and explosion. ISO Rating: If rating is in Bold, rating info was confirmed in Dec. 2016. see (http://www.isomitigation.com)

ISO collects information on municipal fire-protection efforts in communities throughout the United States (and assigns) a Public Protection Classification from 1 to 10. Class 1 represents exemplary public protection, and Class 10 indicates that the area's fire-suppression program doesn't meet ISO's minimum criteria. By classifying communities' ability to suppress fires, ISO helps the communities evaluate their public fire-protection services. When ISO develops a single Public Protection Classification (PPCTM) for a community, all of the community's properties receive that classification. In many communities, ISO develops a split classification: the first number is the class that applies to properties withing five miles of the responding fire station and within 1,000 ft. of a creditable water supply; the second number is the class that applies to properties within five road miles of a fire station but beyond 1,000 ft. of a creditable water supply.

Major Transportation Incident

Air Transportation / Military Aircraft Incident

The presence of the Burlington International Airport and the Vermont National Guard in the City of South Burlington raises the potential for a crash of a passenger, cargo or military plane or helicopter. For the purposes of developing regional hazard mitigation strategies, assessing the likelihood and potential damages from such incidents is a difficult endeavor due to the simple fact that, unlike natural hazards, such incidents are rare. There is no history of large aircraft crashing in Chittenden County, though emergency landings have taken place at the airport. A small plane approaching the airport crashed in Williston in November 2005, resulting in a single fatality. Local officials indicate that other small aircraft crashes have taken place in the past.

It is worth noting that during the public review and comment period in the summer of 2016 on the 2017 MJAHMP, the CCRPC received several comments expressing concern over the potential impacts of the basing and operation of F-35 fighter jets scheduled to be in service at the Vermont Air National Guard base at the Burlington International Airport in South Burlington starting in 2019. Manufactured by Lockheed Martin, the F-35 Lightning II is a single-seat, single-engine, all-weather stealth multi-role fighter designed to perform ground attack and air defense missions. Commentors raised the following primary concerns over the pending basing and operation of this aircraft:

- Potential crash in populated areas, primarily South Burlington and Winooski.
- The potential effects on the public from an F-35 crash especially due to the aircraft's use of advanced composite materials which would release toxic smoke and fibers.
- The adequacy of any mutual aid agreements and training to enable municipal fire departments to respond to the crash of an F-35.
- The use of firefighting foam during training exercises and its impacts on groundwater.

It should be noted that preparedness, response and recovery are the Emergency Management functions by which this hazard is primarily addressed. Addressing the issue of the potential hazards of both civilian and military aircraft operations is currently a multiparty endeavor. The airport is managed by the City of Burlington, and the terminal is patrolled by officers with the Burlington Police Department. The Federal Transportation Security Administration (TSA) handles passenger and cargo screening and perimeter security.

Burlington International Airport's "Airport Emergency Plan" notes as follows: *"The Vermont Air National Guard (VTANG) Fire Department provides aircraft rescue and firefighting (ARFF) equipment and personnel for all civilian and military operations. This service is provided 24 hours per day, 365 days per year. Off-airport fire and emergency response services support the Vermont Air National Guard Fire Department through mutual aid agreements maintained by VTANG ARFF."*

For the purposes of how to address the public comments on the F-35 first and foremost it is useful to emphasize that this MJAHMP concerns itself with Regional Mitigation Strategies. At the regional level, the CCRPC and the AHMPUC have taken no formal position on the pending basing and operation of the F-35 fighter. The CCRPC and committee noted that any type aircraft, civilian or military, could crash at the airport. Lastly, the two primary municipalities that have engaged in extended discussions and public debate are the City of Winooski and the City of South Burlington.

Marine Incident

Another potential transportation incident is the grounding or sinking of a commercial passenger/car ferry or excursion/cruise vessel in Lake Champlain. There are two passenger/car ferry routes in Chittenden County, both operated by the private Lake Champlain Transportation Company. The first route is a one-hour crossing from the waterfront in Burlington to Port Kent, New York. Serving primarily tourists, it operates from Memorial Day weekend through mid-October. The second route is a 20-minute crossing from the terminus of Ferry Road in Charlotte to Essex, New York. It operates year-round and serves primarily commuting workers. An incident with a Lake Champlain Transportation Company ferry occurred in Grand Isle in January 2009. A ferry hit a dock, damaging the dock and causing three injuries, although none were serious. An event of this sort in the more crowded Burlington harbor would likely cause significantly more damage, but the risk of this has not been evaluated.

Several companies, all operating from the Burlington waterfront, operate excursion or cruise vessels during the tourist season. The Lake Champlain Transportation Company operates the vessel, *Northern Lights,* capable of accommodating up to 150 guests. Lake Champlain Shorelines Cruises operates the 500-passenger vessel, *The Spirit of Ethan Allen III.* The Whistling Man Schooner Company operates a 17-passenger sailing sloop, the *Friendship*. No data concerning the likelihood of such vessels grounding or sinking was available.
Collision, grounding, or sinking of small, non-commercial watercraft can also occur and cause loss of life. Response to these maritime incidents is the responsibility of the U.S. Coast Guard.

Rail Transportation Incident

The potential crash of a freight or passenger train is another hazard worth consideration. Two rail lines transit the county, the New England Central Railroad and Vermont Railway. Both lines rely on freight traffic for their primary income. Serious rail accidents in Vermont are rare. The worst train disaster in Chittenden County in recent memory took place in 1984, when a train derailment in Williston resulted in five deaths and over 200 injuries. Emergency response in that incident was hindered by the lack of road access to the accident site. Local officials have some concern over the status of rail infrastructure, as erosion undermining tracks caused a freight train derailment in Middlebury (in neighboring Addison County) in 2007. In that incident, concerns about hazardous materials resulted in parts of Middlebury being evacuated. Burlington officials note that almost all of the fuel oil delivered to Chittenden County arrives by rail and is off-loaded along the Burlington waterfront. A rail incident that halts fuel oil delivery, even for a few days, would affect the ability of residences and businesses to maintain heat and hot water.

New England Central Railroad originates in East Alburg near the Canadian border and then proceeds through Swanton and St. Albans in Franklin County before it heads south through Milton and Colchester and then continues southwest to a station in Essex Junction wherein the line heads due east along the Winooski River through Williston, Richmond and Bolton and thence to Montpelier and White River Junction, and then south along the Vermont/New Hampshire border. The Railroad also operates the short "Winooski subdivision" line from Essex Junction into the Burlington yard of the Vermont Railway. The primary commodities carried by this line in recent years are lumber, paper and steel.

New England Central Railroad operates its entire line on land owned by one of the largest railroads in North America, Canadian National, which also owns the line between East Alburg and Montreal. The Railroad also hosts Amtrak passenger service, the Vermonter, which runs once a day, southbound in the morning and northbound in the afternoon between St. Albans, New York City's Penn Station and Union Station in Washington, D.C.

Vermont Railway originates in Burlington and heads due south through South Burlington, Shelburne and Charlotte in a corridor located between the shore of Lake Champlain and U.S. Route 7. The line continues down to Middlebury, then to Rutland and terminates in Hoosick Junction, New York. A new Amtrak passenger service from Burlington to New York City, an extension of the Ethan Allen Express, will start in July 2022.

The risk of a hazardous material spill as a result of a railway accident has not been evaluated but is of concern to officials in towns along the railroad right-of-way. One comment was received in the summer of 2016 on the 2017 draft MJAHMP regarding rail operations. The commentor expressed concerns noting that *"… reflecting on the tragic Lac-Megantic incident, it would also seem appropriate that the Plan should acknowledge the full range of hazards and impacts that could be associated with a derailment, especially if near the Lake Champlain waterfront in Burlington"* asking for example, *"would the water supply for the City of Burlington and the Champlain Water District potentially be affected? For how long?"* The c*omments also recommended exploration of:*

- *Preparedness steps ….to systematically identify and reduce the potential for railroad incident hazards?*
- *What suitable emergency responses and mitigation plans …should be developed?*
- *What plans should be developed for emergency spill containment and cleanup, especially on the Lake and waterways?*

It should be noted that preparedness, response and recovery are the Emergency Management functions by which this hazard is primarily addressed by municipalities. Most importantly, is that municipalities and the state have no authority over rail operations. By operation of federal law as set forth in the Interstate Commerce Commission Termination Act (49 U.S.C. §10101 et seq.) the United States Congress has granted regulatory authority of railroads to the U.S. agency known as the Surface Transportation Board (the "STB"). Railroad operations and safety are regulated by the Federal Railroad Administration (the "FRA"). While there have been one or two trainings regarding rail operations and incidents, there are no continuing education efforts. CCRPC has encouraged Vermont Emergency Management and other relevant entities to provide, 1) ongoing opportunities for emergency response training, and 2) funding for the appropriate emergency response equipment and materials for the communities along these routes.

Road Transportation Incident

The most common form of transportation incident or accident is an automotive accident. The Vermont Agency of Transportation has identified the following High Crash Locations (HCLs) in Chittenden County. The listing here of HCLs is mostly intersections, though the report also lists numerous sections of road with high accident rates. They are not included here because they are identified in the report by mileage, which makes colloquially describing their locations difficult. These road segments are identified in the municipal annexes.

Table 4.10.4: High crash locations in Chittenden County, 2012-2016[208]

Route	System	Town	Mileage	Crashes	($/Accident/1.)
US-2, I-89	Minor Arterial (u)	Colchester	1.830 - 2.030	31	$49,748
US-2, I-89	Principal Arterial (u)	Colchester	2.040 - 2.150	14	$50,707
US-2, S PROSPECT ST., BURLINGTON, <T0000>	Principal Arterial (u)/Urban Collector (u)	Burlington	0.220 - 0.240	72	$21,264
US-2, DORSET ST., SOUTH BURLINGTON	Principal Arterial (u)/Urban Collector (u)	South Burlington	0.490 - 0.500	86	$16,949
US-2, WHITE ST., SOUTH BURLINGTON	Principal Arterial (u)/Urban Collector (u)	South Burlington	0.860 - 0.880	46	$18,013
US-2, PATCHEN ROAD, SOUTH BURLINGTON, VT-116	Principal Arterial (u)/Urban Collector (u)	South Burlington	0.990 - 1.010	75	$21,167
US-2, VT-2A	Principal Arterial (u)/Minor Arterial (u)	Williston	1.420 - 1.440	71	$25,303
US-2, I-89	Major Collector (r)	Richmond	1.100 - 1.180	12	$45,350
US-2, FAS 0209	Major Collector (r)	Richmond	2.690 - 2.770	27	$11,300
VT-2A, I-89	Minor Arterial (u)	Williston	2.880 - 2.960	21	$26,543
VT-2A, MARSHALL AVE., WILLISTON	Principal Arterial (u)/Urban Collector (u)	Williston	3.320 - 3.340	61	$17,813

208 *Source: Vermont Agency of Transportation* http://vtrans.vermont.gov/docs/highway-research

Route	System	Town	Mileage	Crashes	($/Accident/1.)
VT-2A, INDUSTRIAL AVE., WILLISTON, MT. VIEW ROAD, WILLISTON	Minor Arterial (u)/Urban Collector (u)	Williston	4.780 - 4.800 22,420	38	$26,116
US-7, <0189>, SWIFT ST., SOUTH BURLINGTON	Principal Arterial (u)/Urban Collector (u)	South Burlington/Burlington	1.720 - 0.010	60	$12,587
US-7, MAIN ST., BURLINGTON, US-2	Principal Arterial (u)	Burlington	2.110 - 2.130	65	$22,337
US-7, PEARL ST., BURLINGTON	Principal Arterial (u)/Minor Arterial (u)	Burlington	2.420 - 2.440	57	$29,502
US-7, BURLINGTON (ALTERNATE US-7)	Principal Arterial (u) Burlington 3.050 - 3.070	Burlington	3.050 - 3.070	27	$26,015
7US-7, W. ALLEN ST., WINOOSKI CITY, VT-15, E. CANAL ST., WINOOS, W. CENTER ST., WINOO, <T0000>	Principal Arterial (u)/Minor Arterial (u)	Winooski City	0.040 - 0.230	163	$18,000
US-7, E SPRING ST., WINOOSKI CITY, W SPRING ST., WINOOSKI CITY	Principal Arterial (u)/Urban Collector (u)	Winooski City	0.430 - 0.450	38	$38,900
US-7, VT-2A	Principal Arterial (u)/Minor Arterial (u)	Colchester	3.580 - 3.650	37	$28,908
VT-15, EAST ST., WINOOSKI CITY	Principal Arterial (u)/Urban Collector (u)	Winooski City	0.190 - 0.210	26	$42,296
VT-15, DION ST., WINOOSKI CITY	Principal Arterial (u)/Urban Collector (u)	Winooski City	0.570 - 0.590	30	$27,117
VT-15, I-89	Principal Arterial (u)	Winooski City	0.700 - 0.720	36	$33,372
RD., ESSEX JUNCTION VILLAGE	Principal Arterial (u)/Urban Collector (u)	Essex	0.510 - 0.660	84	$19,056
VT-15, WEST ST. EXT., ESSEX JUNCTION VILLAGE	Principal Arterial (u)/Urban Collector (u)	Essex	0.960 - 1.080	43	$26,451

Route	System	Town	Mileage	Crashes	($/Accident/1.)
VT-15, OLD STAGE RD., ESSEX	Principal Arterial (u)/Urban Collector (u)	Essex	4.070 - 4.170	31	$29,826
VT-116, FAS 0210	Minor Arterial (r)/Major Collector (r)	Hinesburg	5.410 - 5.510	35	$41,266
VT-116, CHEESEFACTORY RD., SOUTH BURLINGTON	Principal Arterial (u)/Urban Collector (u)	South Burlington	0.160 - 0.320	14	$52,321
VT-117, FAS 0213	Minor Arterial (r)/Major Collector (r)	Richmond	0.650 - 0.750	15	$16,447
BURLINGTON (ALTERNATE US-7), MAIN ST., BURLINGTON	Principal Arterial (u)	Burlington	0.990 - 1.010	98	$20,311
BURLINGTON (ALTERNATE US-7), PEARL ST., BURLINGTON	Principal Arterial (u)/Minor Arterial (u)	Burlington	1.310 - 1.330 17,100	61	$28,308
BURLINGTON (ALTERNATE US-7), NORTH ST., BURLINGTON	Principal Arterial (u)/Urban Collector (u)	Burlington	1.620 - 1.640	19	$23,489
SO. BURLINGTON (FAP 121-1 KENNEDY DRIVE), DORSET ST., SOUTH BURLINGTON, I-89	Minor Arterial (u)/Urban Collector (u)	South Burlington	0.000 - 0.010	40	$13,230
COLCHESTER AVE., BURLINGTON, BARRETT ST., BURLINGTON	Minor Arterial (u)/Urban Collector (u)	Burlington 0.990 - 1.010	0.990 - 1.010	34	$71,312
BATTERY ST., BURLINGTON, MAIN ST.	Principal Arterial (u)	Burlington	0.220 - 0.240	45	$25,276
VT. 127 BELTLINE, BURLINGTON, <5009>	Freeway/Expressway (u)	Burlington	1.340 - 1.500	5	$110,720
COLCHESTER AVE., BURLINGTON, EAST AVE., BURLINGTON	Minor Arterial (u)	Burlington	0.430 - 0.450	44	$27,091
MAIN ST., BURLINGTON, ST. PAUL ST., BURLINGTON	Principal Arterial (u)/Urban Collector	Burlington	0.250 - 0.270	39	$25,156

Route	System	Town	Mileage	Crashes	($/Accident/1.)
MAIN ST., BURLINGTON, S UNION ST., BURLINGTON	Principal Arterial (u)	Burlington	0.520 - 0.540	37	$30,689
NORTH AVE., BURLINGTON, NORTH ST., BURLINGTON	Minor Arterial (u)/Urban Collector (u)	Burlington	0.180 - 0.200	20	$27,305
NORTH ST., BURLINGTON, N CHAMPLAIN ST., BURLINGTON	Principal Arterial (u)/Urban Collector (u)	Burlington	0.220 - 0.240	21	$30,219
N UNION ST., BURLINGTON, S UNION ST., BURLINGTON, <T0000>	Principal Arterial (u)	Burlington	0.000 - 0.010	19	$32,211
N UNION ST., BURLINGTON, NORTH ST., BURLINGTON	Principal Arterial (u)/Urban Collector (u)	Burlington	0.300 - 0.320	15	$11,300
PARK ST., BURLINGTON, NORTH ST., BURLINGTON	Principal Arterial (u)/Urban Collector (u)	Burlington	0.280 - 0.300	19	$28,147
PEARL ST., BURLINGTON, <T0000>, S PROSPECT ST., BURLINGTON, COLCHESTER AVE., BURLINGTON	Minor Arterial (u)/Urban Collector (u)	Burlington	0.930 - 0.940	43	$33,633
PATCHEN ROAD, SOUTH BURLINGTON, WHITE ST., SOUTH BURLINGTON	Urban Collector (u)	South Burlington	0.080 - 0.100	34	$18,444
SUSIE WILSON RD., ESSEX, KELLOGG ROAD, ESSEX	Urban Collector (u)	Essex	0.480 - 0.500	63	$18,652
VT. 127 TH, COLCHESTER, E. LAKESHORE DR., COLCHESTER	Minor Arterial (u)/Urban Collector (u)	Colchester	3.170 - 3.250	26	$20,208

Road Infrastructure Failure

Another form of transportation incident is road infrastructure failure. The flooding in 1927 washed out many of the bridges in the county, and significant flooding could have similarly devastating impacts on road infrastructure now. The Winooski River essentially bisects Chittenden County, stretching for approximately 40 miles, forming the town line between several towns and passing through others. There are only eight bridges on public roads crossing the Winooski River, and the incapacitation of even one could create lengthy detours and problems for emergency responders.

The Bridge Street bridge over the Winooski River in Richmond was found to be structurally deficient in 2007 and restricted to single-lane traffic and was closed briefly in the fall of 2008 to all but pedestrians and bicycles. Though the bridge was repaired in spring 2009, the six-week closure forced all automotive traffic to take an approximately eight mile detour. The bridge closure also had a significant negative impact on local emergency response capability and businesses in downtown Richmond. While the likelihood of a catastrophic bridge failure has not been evaluated for Chittenden County, the situation in Richmond has shown that even a non-catastrophic bridge closure can have a large impact on the community.

Another bridge that closes periodically due to natural hazards is the North Williston Road bridge over the Winooski River between Essex and Williston. During high water and flood events the roads leading to the bridge span itself become inundated and must be closed by the respective Town police departments. Closures typically only last a day or two but some commuter and truck traffic is impacted.

The Vermont Agency of Transportation regularly inspects bridges. In terms of vulnerabilities to natural disasters bridges are most susceptible to damage or failure from floods and fluvial erosion. One mechanism to assess potential vulnerability is to assess potential damage from “scouring” or aggradation and degradation of the river bed due to erosion. In addition to examining decking, load and other features of a bridge, the inspection also assigns a “Scour Critical” rating. Bridges receiving a score of 3 or lower are considered Scour Critical. Only a few bridges have received this rating and are noted in the appropriate municipal annex.

Non-Profiled Hazards

Air Pollution

A less visible but long-term concern is air pollution. The U.S. Environmental Protection Agency (EPA) sets nationwide air quality standards for ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide, particulate matter, and lead. Chittenden County’s air complies with these federal quality standards. Particulates and ozone are the two pollutants of most concern in Chittenden County. Most of the measured pollutants, including ozone, are generated predominantly by motor vehicles and out-of-state sources. Some of these include pollution from coal-burning power plants located in the Midwest. Scientists believe that acid rain is caused by the emissions from these power plants.

According to the *2013 ECOS Plan*, air quality in Chittenden County is generally quite good. For example, recent statistics show: For particular matter, the EPA's current standard is 12 micrograms per meter. In 2003, (when the standard was 15.0) the county's test results showed 9.5 micrograms but has steadily decreased to 6.8 micrograms by 2015. For ozone matter, the EPA standard is 0.075 micrograms per meter. In 2003 (when the standard was 0.080), the county's test results showed 0.078 micrograms but has steadily decreased to 0.062 micrograms by 2015.

SECTION 4.11: SOCIETAL HAZARDS

The following discussion of societal hazards is based upon qualitative information from discussions with Chittenden County law enforcement professionals as well as quantitative data from the Federal Bureau of Investigation.

Table 4.11.1: Societal Hazard Profile Summaries

Hazard	Is Location data available?	Are Extent data available?	Is Impact data available?
Crime	County-wide. Significant incidents could happen anywhere.	Data collection is not standardized across all municipalities.	Significant socio-economic impacts.
Civil Disturbance	County-wide. Significant incidents can happen anywhere.	No formal damage has been documented to date.	No formal damage has been documented to date.
Terrorism	The FBI does not share a list of potential targets.	Unknown but assumed to be significant if incident occurs. Additional information on cyber-attack provided.	Unknown but assumed to be significant if incident occurs. Additional information on cyber-attack provided.
Economic Recession	County-wide.	Historic data on unemployment levels & poverty rates.	Longer lasting impacts hard to measure below county level.
Key Employer Loss	Depending upon type of employer.	No formal database of damages.	No formal database of key employer loss is maintained.

Crime

Hazard Description

Compared to previous mitigation plans, this 2017 Plan will not attempt to go into detail on crime statistics. It should first be noted that preparedness, response and Recovery are the Emergency Management functions by which this hazard is primarily addressed by municipalities. Additionally, there is no regional police authority. However, municipal police departments, the Chittenden County Sheriffs and the Vermont State Police cooperate frequently with each other as needed on discrete issues. For example, in 1992, law enforcement agencies, the State's Attorney and social service organizations formed the Chittenden Unit for Special Investigations or CUSI.[209]

[209] Chittenden Unit for Special Investigations website, http://cusi-vt.org

The Chittenden Unit for Special Investigations (CUSI) is a multi-agency task force providing criminal investigative services in response to reports of sexual assault, other serious sexual offenses and serious child abuse and neglect. As a collaborative unit, CUSI works in conjunction with the towns and local police agencies within the borders of Chittenden County, as well as with prosecutorial entities, medical experts, the Department for Children and Families, and Victim's Advocate groups to better investigate, prosecute, and intervene in situations of abuse. CUSI operates on a referral process and receives reports of sexual offenses or serious child abuse and neglect from partners throughout the state. In promoting professional collaboration among law enforcement agencies and victim care providers, CUSI prioritizes the multi-faceted needs of a child or adult victim. Within the community, CUSI promotes education, advocacy and awareness regarding the prevention of abuse at all levels. The Unit strives to perform its mission lawfully and with intelligence, dedication, fairness, compassion, and competence while insuring special sensitivity to the needs of victims.

Extent

The extent of the damage of an active criminal attack can be measured by the number of casualties. In 2019, the highest number of casualties for a single incident was 45 (23 killed and 22 wounded) at the Cielo Vista Walmart Supercenter in El Paso, Texas. The second highest number of casualties was 36 (9 killed and 27 wounded) at the Oregon Historic District in Dayton, Ohio. More recently, law enforcement agencies have been working together with the CCRPC to explore the development of regional dispatch services and addressing the abuse of opioids in the county. Crime statistics for the Vermont State Police are primarily for crimes occurring in towns without municipal police departments, namely: Westford, Underhill, Bolton, Huntington, Buels Gore and Charlotte; however, the available data incidents in these towns were not available.

Table 4.11.2: 2019 Crime Statistics, Chittenden County[210]

Agency Name	Population	Volent Crime	Property Crime
Burlington	42,958	174	1110
So. Burlington	19,687	22	687
Essex	22,213	19	286
Winooski	7,346	23	128

[210] US Dept. of Justice, Federal Bureau of Investigation, Uniform Crime Reporting Statistics https:crime-in-the-us/2019/tables/table-8/table-8-state-us/Vermont.us

Agency Name	Population	Volent Crime	Property Crime
Colchester	17,548	26	234
Milton	11,064	11	117
Shelburne	7857	1	110
Richmond	4,178	1	13
Williston	10,026	8	205
University of VT.	15,629	3	93
Hinesburg	4601	5	23
2019 County Total	163,107	293	3006
2015 County Totals	161,295	189	3249

It is interesting to note that volent crime has increased and property crimes have decreased over the four years from 2015 through 2019.

Table 4.11.3: 2019 Crime Rates per Capita, Chittenden County, 2010 - 2019[211]

	2010	2011	2012	2013	2014	2015	2019
Violent Crime Rate Per Capita	0.0015	0.0019	0.0015	0.0012	0.0009	0.0012	0.0015
Property Crime Rate Per Capita	0.0302	0.0302	0.0305	0.0256	0.0204	0.0213	0.0302

Previous Occurrences

The CCRPC along with its municipalities feel that including a discussion of crime, especially crime related to drug addiction, in this Plan is appropriate due to its role in worsening significant societal impacts. An April 2016 report by the Vermont Association for Mental Health and Addiction Recovery, “The Scope of the Opiate Crisis in Vermont” provides a useful overview of the issue at hand.

History

OxyContin and other prescription opiates:

[211] US Dept. of Justice, Federal Bureau of Investigation, Uniform Crime Reporting Statistics

- In the late 2000s, the opiate of choice was OxyContin: more people were prosecuted in federal court in Vermont in 2010 for illicit trafficking in prescription opiates than for any other drug, including marijuana, heroin and cocaine.
- Vermont ranked second in the country in per-capita admissions for treatment for addiction to prescription opiates.
- The number of Vermonters seeking treatment for opiate addiction in 2010 was up 21 percent from 2008 and up 300 percent from 2005.

Heroin

- To combat abuse of prescription opiates, OxyContin's delivery system and regulation was redesigned in 2010, making it highly resistant to being crushed for the purposes of getting a high, and making it far more expensive. However, this made things worse, as users simply switched to heroin, which is more dangerous, as it is unregulated, but is also only 1/8 as expensive as OxyContin.
- There are claims that heroin is easier to find than marijuana in many parts of Vermont.
- In 2014, the state treated 2,258 people for heroin use, a 64 percent increase over 2013 and more than three times the 623 people treated in 2010.

Statistics

Deaths

- In 2013, the number of people who have died from heroin overdoses nearly doubled from 2012.
- More than 50 Vermonters die every year from opioid poisoning.

Reporting

- Since 2000, Vermont has seen an increase of more than 770 percent in people seeking treatment for opiate addictions, up to 4,300 people in 2012.
- For people receiving heroin treatment specifically, there was an over 250 percent increase in Vermont between 2000 and 2014, the greatest increase being a nearly 40 percent spike in just 2013.
- Rutland also has the highest rate of pregnant women with opiate addiction in the United States.

Crime and Prosecution

In 2013, there were twice as many federal indictments against heroin dealers than in the prior two years, and over five times as many as had been obtained in 2010. Close to 80 percent of the state's inmates "are either addicted or in prison because of their addiction.

Motivations in the Current Heroin Crisis

- Profits for dealers - Vermont attracts heroin dealers for its high profit margins – a dealer can buy heroin in Springfield, Massachusetts, for as little as $6 a bag and sell it in Vermont for $30, and they do, for $2 million in heroin is trafficked every week in Vermont.
- Convenience for dealers - The state has convenient highways that feed directly into big cities such as Montreal, Boston, New York and Philadelphia, so dealers can easily travel a few hours on the interstate to Vermont and sell drugs at a price 500 percent higher than in out-of-state major cities.

Location

The entire planning area is subject to this hazard.

Future Probability

The planning area could experience one incident in the next five years.

Vulnerability

The demand on services can be acute. An October 2015 report in a local newspaper, *Seven Days*, reported on the situation at the Chittenden Clinic located in South Burlington in the heart of the County: "There are nearly 300 people on the "active" waiting list for medication assisted treatment at the Chittenden Clinic, despite a doubling of the number of patients the clinic serves, according to Bob Bick, Howard Center CEO. In 2014, the clinic treated 441 patients; today 894 patients receive treatment for opiate addiction at the clinic. More than half of the patients are injection heroin users." Local police chiefs interviewed during the development of local AHMPs noted the crime fueled by the addiction crisis on one hand and the dealers looking to profit. These crimes include robbery, theft, prostitution and impacts to families and children.

> *"To begin to better understand the nature of this crisis, regional entities have formed the Chittenden County Opioid Alliance. The Alliance is based on the premise that no one organization can reduce the burden of the opioid crisis in Chittenden County alone. The Alliance is made up of many dedicated people who come from different sectors of the community and have partnered together- local non-profit agencies, state and local government, business leaders and community members in Chittenden County.*
>
> *The organizational structure of the Alliance is based on a Collective Impact model, which enables successful collaboration with a variety of organizations that share a common agenda and outcomes. This model is based on the principle that there are key decision makers at the table to help guide and proliferate the work of the Alliance. These key decision makers comprise the Chittenden County Opioid Alliance Steering Committee."*
>
> *The Committee has four Action Teams, working to develop strategies in four areas specific to the opioid crisis:*

- *Workforce Development*
- *Community-Level Prevention*
- *Treatment Access and Recovery Support*
  - *CommunityStat Rapid Intervention*

With funding from the various partners, CCRPC's primary role is administrative and managerial. Funds provided to the CCRPC are used to retain a Project Director and a Data Manager. Their role is "to ensure that all current efforts to address the opioid issue work synergistically, and to aid in developing new and creative solutions to the problem that we all work on collectively."[212]

Civil Disturbance

Hazard Description

The term "civil disorder" is defined by 18 USCS § 232 as any public disturbance involving acts of violence by assemblages of three or more persons, which causes an immediate danger of or results in damage or injury to the property or person of any other individual.

Location

The incident can happen any place, but the main locations are around Federal, State, or Local Government Buildings as well as Police Stations depending on the intentions of the crowd.

Extent

Even though it is an angry group of people there are various levels of disturbance that can come out of a civil unrest. The least impact is if crowds gather to yell, scream, or protest an incident that has sparked the unrest and then move on by dispersing, either voluntarily or by request of authorities. The higher level of disturbance occurs when either a peaceful protest leads to violent or criminal acts, such as starting fires, breaking glass, and other vandalization of the community, or the initial intent of the crowd is to commit one of these acts of violence. The worst-case scenario can also lead to lives lost in both the crowd of angry citizens and those trying to keep the peace.

Historical Occurrence

CCRPC staff was unable to locate any systematically collected historical data on the occurrences of riots or other forms of civil disturbance. In completion of the 2011 version of the Plan, staff queried municipal officials about instances of such disturbances occurring at municipal events, places of assembly or entertainment or sporting events. Officials with the City of Burlington and the University of Vermont did mention prior incidents of dealing with unruly

[212] http://www.ecosproject.com/chittenden-county-opioid-alliance/alliance/

crowds at local music venues and/or bars and clubs. A concern was also expressed by the City of South Burlington Fire Chief over the potential for civil disturbances at hotels or conference centers during a speech by, or appearance of, a politically controversial figure.

In development of the 2017 Plan, some municipal staff again reaffirmed the potential for a disturbance due to a political event. Even though Burlington is a small city, it can attract high profile figures. In January 2016, Republican Party Presidential candidate Donald Trump held a rally at a downtown theater which attracted about 2,000 supporters and an accompanying crowd of 700, mostly protesters. Democratic Party Presidential candidate Bernie Sanders kicked off his campaign in May 2015 with a crowd estimated at 5,500. In the fall of 2011, the “Occupy Wall Street movement” camped in Burlington’s downtown City Hall Park. There have also been sporadic, smaller protests in 2016 against the expansion of Vermont Gas distribution lines with opponents staging a “sit-in” at Vermont Gas’s office in South Burlington and chaining themselves to construction equipment at sites in Essex and Williston.

More recently, small, localized incidents of civil unrest, primarily in Burlington, have resulted in response primarily to incidents related to potential “use of force” police actions (protests in 2020 in response to the Black Lives Matter movement), as well as actions taken by officials in response to COVID-19 restrictions closing businesses and other gathering places.

Probability of Future Event

Civil disturbances are sparked by many things, so predicting when or if this will occur again in any one location is not going to be completely accurate. There is always a chance it will happen but there is no guarantee that it will.

Vulnerability and Impact

Those who are near a crowd of angry citizens are more vulnerable than the people who view such incidents in the media. However, because such crowds may be mobile, they may move from one location to another. Those outside the gathering should maintain awareness and vigilance in how the groups shift direction. The impact will also vary depending on what is destroyed by the angry group and to what extent the group causes damage. Agitated groups are likely to use roadways in moving from one place to the next, so motorists should be aware of their environment.

Several police departments in the county, including the University of Vermont’s police services, possess crowd-control gear and other mechanisms. The Vermont National Guard also has crowd control training and equipment. It should be noted that preparedness and response functions are the Emergency Management functions by which this hazard is primarily addressed.

Terrorism

Hazard Description

Regarding terrorism in Vermont, the 2018 Vermont State All-Hazards Mitigation Plan states: Terrorism and civil hazards include actions intentionally aimed at threatening lives and property. They may range from a single person on a shooting rampage to a cyber-attack that harms computer systems, to the organized use of weapons of mass destruction (WMD). WMD events could involve chemical, biological, explosive or radioactive weapons. The Vermont State Police conducted a risk/threat assessment of potential WMD attacks in 2000 that ranked potential targets by State Police district. At that time, no known or suspected terrorists had been identified as operating in Vermont. However, some in the U.S intelligence community believe that radical Islamist/extremist organizations may have small cells in Montreal and Toronto, not far from the U.S. border. In this regard, Vermont is considered a potential transit point for terrorist organizations operating out of Canada who may travel through the state to reach points to the south.

Location

Such weapons can be found in the storage facility used by the maker, or the user can transport the device to any public or private venue. Criminals or terrorists frequently make demands (financial or otherwise) in exchange for not using the weapon.

Extent

While radiological weapons are the deadliest form of this type of weapon, it is difficult to secure materials needed to create an effective device. It is easier to create a mix of chemicals and biological agents since many of these are of natural origin or can be stolen from known storage locations. However, using an effective concentration and combination of these mixtures requires expertise beyond the level of expertise of most persons.

Historical Occurrence

It should be noted that preparedness, response and recovery are the Emergency Management functions by which this hazard is primarily addressed. There was one significant incident of cyber-attack reported in Chittenden County. The University of Vermont Medical Center's reported that it was a ransomware attack that downed the hospital's online systems in October 2020.[213] The attackers left a link in a single folder on a network computer to contact the hackers. It presumably led to a ransom request — but hospital officials never opened the link to check. "We considered it for about five seconds," said Doug Gentile, senior VP of network information technology. Ultimately, hospital leadership concluded that contacting the hackers or paying a ransom wouldn't have saved time or effort. The perpetrators and methods of the attack were not revealed due to a pending investigation by the Federal Bureau of Investigation.

[213] Ransomware downed UVM Medical Center systems, but no payment made - VTDigger

Other hospitals attributed attacks around the same period to Russian-speaking attackers using "Ryuk" malware. When UVM hospital IT staff realized their system had been breached they shut down the internet and health records system to prevent further infiltration.

The attack also downed the phone system, cut off access to staff emails and medical records, and slowed the hospital's ability to track appointments and scheduling. Within hours, hospital staff conducted a scan of the system and found a folder with a link to a website with instructions to contact the attackers. Ultimately, they never went to the site to get the message, and never had direct communication with the attackers.

In the weeks after the incident, UVM Medical Center furloughed and reassigned more than 300 employees. The estimated cost of the attack and subsequent recovery was about $1.5 million a day in lost revenue and expenses.

Probability of Future Events

There is always a possibility that a terrorist attack of some type could happen; however, given the time it takes to plan, develop and implement such an incident, and the in the absence of high-risk targets, makes it less likely at this time. Although the overall terrorist threat is fairly low in Vermont, the most probable form of terrorism is expected to be in the form of a conventional bombing, hijacking, kidnapping, or shooting incident. A Weapons of Mass Destruction (WMD) attack in Vermont is considered a low probability; however, it is recognized as having the potential for catastrophic consequences. Many state agencies and departments have created internal protocols outlining their actions in a terrorism incident, and the Governor has established the State of Vermont Terrorism Task Force to create the statewide plan to deal with terrorism.

Vulnerability and Impact

Those most vulnerable would be near the area of impact at the time of detonation. People are best protected by immediately seeking shelter, although weapon components may remain in the atmosphere for hours, days, or longer. The impact varies depending on the type of WMD; whether the device was chemical, biological, or radiological; and whether there is an available antidote.

Although the chances of a terrorist incident occurring in Chittenden County are low, the county contains numerous critical facilities that could be considered potential targets of terrorism. These include local, state, and federal government buildings, military installations, transportation hubs, large employers, health care facilities, schools and universities, churches and synagogues, major shopping areas, and public gathering places. The Vermont Homeland Security unit of the Department of Public Safety maintains a specific list of possible terrorism targets.

Nonetheless, additional analysis of the potential threat from terrorism is ongoing, due to the actual use of hijacked aircraft as flying bombs and biological weapons (anthrax in letters) in September and October 2001.

A vulnerability analysis was completed by the Vermont DEC Dam Safety Section (11/1/01) on the potential of an intentional breach of dams that normally hold back at least 1,000 acre-feet of water. This study identified 15 sites where security could be focused. Vulnerability studies have resulted in security upgrades to Vermont Yankee, the State Buildings Department, and Burlington International Airport.

Vermont has a Terrorism Task Force and Homeland Security (DHS) Unit that monitor potential threats and acts of terrorism to better anticipate, prevent or respond to incidents.

Economic Recession

The United States formally entered a recession in December 2007, which dramatically accelerated in September 2008. While Vermont was not among the states hardest hit by the recession, the state, including Chittenden County, certainly felt the effects of the downturn. According to the Vermont Department of Labor, unemployment in Vermont increased by 2.6 percent to 6.7 percent between January 2008 and January 2010 and was above 7 percent for much of 2009.

The State of Vermont faced severe budget cutbacks, and most municipalities in Chittenden County cut spending in the face of reduced tax revenue. Consumer and business spending was also reduced, and activity slowed in most sectors of the economy, particularly construction. The Economic Base Analysis in the 2013 ECOS Plan states that between 2000 and 2010 the county saw a net decrease in jobs by 2,263 largely coming from the private sector.

Fortunately, jobs in the County have recovered strongly since the end of the 2007-2008 recession. Data cited in the 2016 ECOS Plan indicates that employment has grown rapidly in recent years. In 2005, there were 94,799 jobs. This dropped to 92,708 in 2009 but has expanded dramatically since then and stood at 101,260 in 2015.

As of the 2020 U.S. Census, total county employment was at 88,025, a significant drop since 2015. More recent statistics illustrate the long-term impact that the COVID-19 pandemic has had on jobs and employment in the county. In March 2021, there were 89,203 employed in Chittenden County, with an unemployment rate of 3.6 percent. By March 2022, the numbers began to show some recovery from the impacts of COVID-19 on jobs in early 2020, with the number employed having increased to 92,572, and an unemployment rate of 1.6 percent.

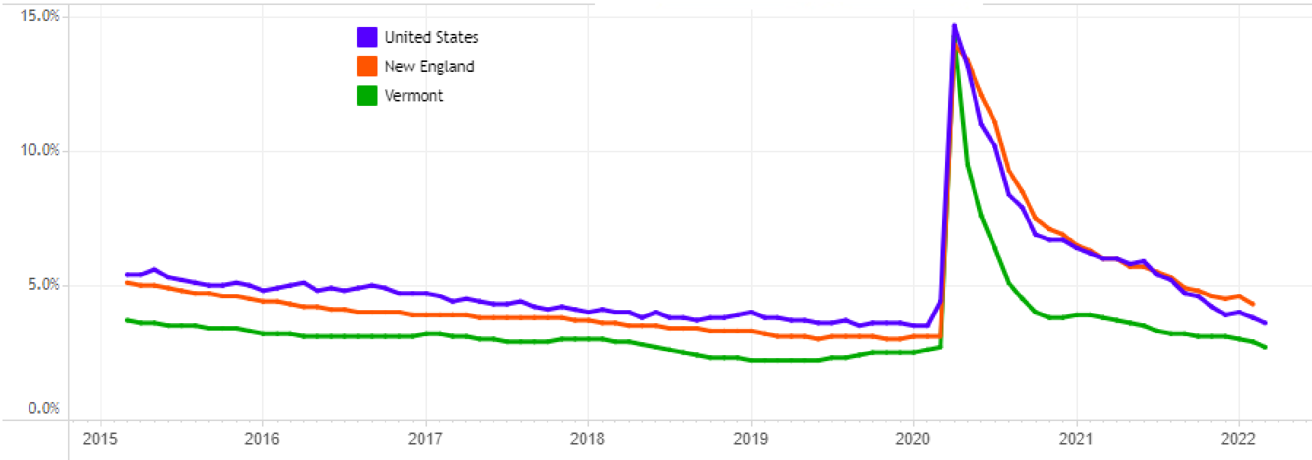


Figure 4.11.1. Unemployment Rate in Chittenden County, 2015-2022[214]

Key Employer Loss

For the purposes of this Plan, a key employer loss was defined as severe job layoffs or closure of a key employer in a given municipality. The loss of a major employer could cause dramatically increased unemployment, reduce property values due to out-migration of terminated employees, and cause layoffs or facility closures at businesses dependent upon the key employer and its employees.

The closure of the Saputo Cheese Factory as a result of fire in 2008 met this definition. The factory, which employed roughly 80 people, was the third largest employer in the town of Hinesburg. As a result of the closure, Hinesburg experienced a significant revenue loss, both from the factory itself and the affected employees. The site has since been redeveloped. The

Global Foundries operates a facility, purchased from IBM, in Essex Junction and Williston that, employs roughly 3,000 people today down from around 6,000-8,000 when IBM operated the plant in the early 2000s. Major employers include:

Table 4.11.: Major Employers in Chittenden County, 2015-2016[215]

Name	Location	Primary Business	Employees
UVM Medical Center	Burlington	Physicians & Surgeons	7351
IBM (Global Foundries)	Essex Junction	Computers-Electronic-Manufacturers	4000
University Of Vermont	Burlington	Universities & Colleges Academic	3446
People's United Bank	Burlington	Banks	1000
DEALER.COM	Burlington	Website Hosting	838

214 Vermont Department of Labor, March 2022 Report.
215 Vermont Business Directory, 2015/2016

Name	Location	Primary Business	Employees
Ben & Jerry's Homemade Inc	South Burlington	Ice Cream Parlors	735
GE Healthcare	South Burlington	Computer Services	700
Green Mountain Power Corp	Colchester	Electric Contractors	605
St Michaels College	Colchester	Universities & Colleges Academic	470
Burton Snowboards Mfg Ctr	Burlington	Manufacturers	375
Champlain College	Burlington	Universities & Colleges Academic	310
PC Construction Co	South Burlington	General Contractors	276

Note: Employee counts can include some positions located outside of Chittenden County and located in other locations within the County.

In addition to having a diversity of major employers, the County also has a robust private sector. The 202 U.S. Census data reported a total of 4,467 employer establishments, with an annual payroll of $4,468,986. The highest total revenues were in the manufacturing field, retail sales, and health care and social assistance.

Non-profiled Hazards

Food Supply Crisis

Some state and local officials have become concerned with the ability of local and regional food systems to adequately feed the population in the event of a fuel shortage or other emergency that disrupts inter- and intra-state food supply chains. South Burlington is the only municipality in Chittenden County that has comprehensively analyzed all the relevant issues and has developed a food security plan, which includes: calorie and food group needs for the forecasted population, current amounts produced of each food group, production surpluses and shortfalls relative to forecasted food group needs, potential for expanded production or new crops to meet forecasted needs, availability of resources required to meet food production needs (e.g., land, water, labor, animal feed, seeds, fertilizer, fuels to support food production and getting food to market, etc.). Such an analysis for the remaining municipalities is beyond the scope of this All-Hazards Mitigation Plan.

A study conducted by the Intervale Center in Burlington compared current food consumption with production in Chittenden and surrounding counties. This study concluded that Chittenden County and the surrounding region produces more fruit (mostly apples) and dairy products than local demand requires, while additional production of meat (beef, pork, poultry, and associated feed grain), wheat, and vegetables would be required to meet current regional food demand.

SECTION 5: Capabilities Assessment

Overview and Purpose of Capability Assessment

Assessing mitigation capabilities is an integral part of the mitigation planning process in which municipalities identify, review, and analyze current resources that can be used for reducing the impact of hazards on their communities[216]. Assessing capabilities identifies the framework that is in place, or should be in place, for the implementation of mitigation actions[1].

The capability assessment incorporates any new capabilities that have emerged in the past five years since the previous plan was adopted. This section provides a summary of the capabilities of Chittenden County planning participants. Detailed jurisdiction-specific assessments are in the jurisdiction annexes.

Table 5.1: Capabilities Designed to Support Implementation of Hazard Mitigation Activities

Capability	Relationship to Hazard Mitigation
Flood Damage Prevention Ordinance	• Tool used by municipalities to regulate the type of construction that occurs in the floodplain. • All NFIP communities must adopt and enforce a Flood Damage Prevention Ordinance. • The State of Vermont has developed a Model Flood Damage Prevention Ordinance for use by all participating NFIP communities.

[216] Federal Emergency Management Agency. (2016, September) *State Hazard Mitigation Planning Key Topics Bulletins: Mitigation Capabilities*. https://www.fema.gov/sites/default/files/2020-06/fema-statemitigation-capabilities-planning-bulletin_09-26-2016.pdf#:~:text=An%20assessment%20of%20state%20mitigation%20capabilities%20is%20essential,efforts%20targeted%20for%20state-level%20and%20%20local%20planning.

Capability	Relationship to Hazard Mitigation
	• Each NFIP participating community in the planning area must maintain continued compliance with NFIP regulations. • The following steps will be taken by each participating community so it will meet or exceed NFIP minimum requirements: o Deny issuing municipal permits to build in a floodplain. o Inspect proposed development to ensure compliance with the local floodplain management ordinance o Maintain records of floodplain development. o Work with FEMA and local GIS experts to prepare, revise, and update flood maps. o Assist residents in obtaining information on flood hazards, floodplain map data, flood insurance and proper construction measures.
Community Rating System (CRS)	The goal of the CRS program is to reduce flood damages to insurable property, strengthen and support the insurance aspects of the NFIP, and encourage a comprehensive approach to floodplain management. Benefits of the CRS not only include lower flood insurance rates but also the following: • Citizens and property owners increase their knowledge of the risks associated with flood impacts and can evaluate their individual vulnerabilities and learn to take action to protect themselves and their property. • CRS floodplain management activities provide enhanced public safety, reduced damage to property and public infrastructure, and avoidance of economic disruption and loss. • Communities can evaluate the effectiveness of their flood programs against a nationally recognized benchmark. • Technical assistance in designing and implementing some activities is available to communities at no charge. • CRS communities have incentives to maintain and improve their flood programs over time. • The Town of Colchester is the only Chittenden County CRS community (Class 8 status), but the town is not participating in this MJAHMP Update planning process.

Capability	Relationship to Hazard Mitigation
Storm Water Management	Addresses flooding associated with storm water runoff and is typically focused on design and construction measures intended to reduce the impact of frequently occurring minor urban and suburban flooding, damages to road infrastructure (road base, ditches, culverts, etc.) and increased phosphorus pollution. Nine communities in Chittenden County are designated by the US EPA and Vermont DEC as MS-4 (Municipal Separate Storm Sewer Systems) permitees and therefore have formally adopted stormwater management plans. Other towns in the County, excepting Buels Gore, are subject to Vermont DEC's Municipal Roads General Permit which requires maintaining hydrologically connected segments of roads to a certain standard to minimize erosion and sedimentation.
Zoning Ordinances	Used by local governments to control when, where, and how local development is carried out. Ordinances are a community's "policing" power to protect the public health, safety, and welfare. Such ordinances, often referred to as zoning bylaws or land development regulations, enable municipal governments to limit the type and density of development and serve as a powerful tool when applied in identified hazard areas.
Subdivision Ordinances	Regulates the development of housing, commercial, industrial, or other structures, including associated public infrastructure, when it is subdivided into buildable lots for sale or future development. Exposure of future development to natural hazards may be dramatically reduced by implementing a Subdivision Ordinance.
Building Codes, Permitting and Inspections	Building codes regulate construction standards and affect the type of permitting process required both before and after a disaster; and the enforcement of inspection protocols for hazard risks faced by a community. Under the 2014 VT Senate Bill 2378, all municipalities must enact the Uniform Building Codes unless they opted out prior to November 30, 2014.
Historic Preservation Plan	A Historic Preservation Plan is intended to preserve community historic structures, sites, or districts. An often-overlooked aspect of the historic preservation plan is the assessment of buildings and sites located in areas subject to natural hazards and identifying effective ways to reduce future damages. This may involve retrofitting or relocation techniques that account for the need to protect buildings that do not meet current building standards or are within a historic district that cannot easily be relocated out of harm's way. *(Burlington, Shelburne, and Williston are participants in the Certified Local Government (CLG) Program established by the National Historic Preservation Act Amendments of 1980.)*
Hazard Mitigation Plan (HMP)	The HMP is a community's blueprint efforts to reduce the impact of natural and human-caused hazards on people and the built environment. HMP elements include a risk assessment, capability assessment, and a mitigation strategy. The Chittenden County participating communities who adopt this multi-jurisdictional AHMP will be considered as having developed an HMP.

Local Emergency Management Plan	Outlines the responsibility and means by which resources are identified, assigned, and deployed during or following an emergency or disaster. Every spring, all towns participating in this MJAHMP update adopt an updated Local Emergency Management Plan.
Continuity of Operations Plan	A continuity of operations plan establishes a clear chain of command, line of succession, delegation of authorities, and plans for backup or alternate emergency facilities in case of an extreme emergency or disaster.
Comprehensive Plan	A comprehensive plan (often called a "town plan" in Vermont) establishes the overall vision for a community and helps to guide municipal decision making related to growth and development.
Economic Development Plan:	An economic development plan serves as a road map for economic development decision making, based on the collection of statistical data, historical perspective, and human potential.

Methodology

Performing a Capability Assessment is a required step in developing a FEMA-approved hazard mitigation plan (HMP) This step includes reviewing community mechanisms that enable a community to implement hazard mitigation activities. Performing the Capability Assessment enables a jurisdiction to identify its regulatory, administrative, technical, and fiscal capacities and capabilities and consider how these tools can be used to further hazard mitigation and disaster resiliency goals.

Resilience is the capacity of communities to survive, adapt, grow, and even transform when conditions require it in the face of stresses and shocks. Building resilience is about making communities better prepared to withstand hazard events and better able to bounce back quickly and emerge stronger from these events. Assessing mitigation capabilities is an essential step toward resilience. Building resilience cannot effectively occur unless there has been an honest assessment of a jurisdiction's capabilities to plan, manage, and assign resources toward long term hazard risk reduction (FEMA). Mitigation capacity building is becoming more prominent and realistically achieved with the implementation of FEMA's Building Resilient Infrastructure and Communities (BRIC) program starting in fiscal year 2020. This program, which replaced the Pre-Disaster Mitigation (PDM) program, supports communities through capability and capacity building, encouraging innovation, promoting partnerships, enabling large projects, maintaining flexibility, and providing consistency.

Conducting the Capability Assessment

In order to gather the information necessary to update the capabilities assessment, municipalities reviewed legislative and departmental capabilities to identify resources, strengths, and gaps for implementing hazard mitigation efforts. The Consultant used information provided in the previous plan to populate a Capabilities Assessment Worksheet for each jurisdiction. Using this Worksheet, the municipalities were asked to review the information from the previous plan and certify that all information previously provided was still current or provide updated information to the consultant noting any changes in capabilities that have occurred since the previous plan. Municipalities that had not previously performed a local capability assessment during the development of the previous plan were asked to do so during the plan update. Follow up telephone calls were made to participating municipalities to explain the purpose of the survey and help in completing it, if needed. Worksheet responses were used to update the capabilities section to reflect each jurisdiction's assessment of their current capabilities.

Planning and Regulatory Capabilities

Chittenden County municipalities have several policies, programs, and capabilities, which help to prevent and minimize future damages resulting from hazards. These tools are valuable instruments in pre- and post-disaster mitigation as they facilitate the implementation of mitigation activities through the current legal and regulatory framework.

Table 5.2.1a: Planning and Regulatory Capabilities[217]

Type of Plan, Ordinance or Program Jurisdiction	Comprehensive Plan	Capital Improvements Plan	Economic Development Plan	Local Emergency Operations Plan	Continuity of Operations Plan	Transportation Plan	Stormwater Management Plan	Community Wildfire Protection Plan	Zoning Ordinance	Subdivision Ordinance	Totals
Bolton	X	-	X	X	-	-	-	-	X	X	6
Buels Gore	X	-	X	X	-	-	X	-	X	X	6
Burlington	X	-	-	X	-	-	X	-	X	X	5
Charlotte	X	-	X	X	-	-	X	-	X	X	6
Essex	X	X	X	X	-	-	X	-	X	X	7
Essex Junction	X	-	-	X	-	-	X	-	-	-	3
Hinesburg	X	X	X	X	-	-	X	-	X	X	7
Huntington	X	X	X	X	-	X	X	X	X	X	9
Jericho	X	X	X	X	-	X	X	-	X	X	8
Milton	-	-	-	X	-	-	X	-	X	X	4
Richmond	X	X		X	-	-	X	-	X	X	6
St. George	X	-	-	X	-	-	X	-	X	X	5
Shelburne	X	-	-	X	-	-	X	-	X	X	5
South Burlington	X	X	X	X	X	X	X	-	X	X	9

217 The checked box (X) indicates that the local government self-reported that the community has on record the applicable code, plan, ordinance, or program. This table includes the Chittenden County Regional Planning Commission (CCRPC) which produces several county-wide plans on a regular basis.

Type of Plan, Ordinance or Program / Jurisdiction	Comprehensive Plan	Capital Improvements Plan	Economic Development Plan	Local Emergency Operations Plan	Continuity of Operations Plan	Transportation Plan	Stormwater Management Plan	Community Wildfire Protection Plan	Zoning Ordinance	Subdivision Ordinance	Totals
Underhill	X	-	-	X	-	-	X	-	X	X	5
Westford	X	X	X	X	-	X	X	-	X	X	8
Williston	X	X	X	X	-	X	X	-	X	X	8
Winooski	X	-	X	X	-	-	X	-	X	X	5
CCRPC	X	-	X	-	X	X	-	-	-	-	4

Table 5.2.1b: Planning and Regulatory Capabilities (Continued)

Type of Plan, Ordinance or Program / Jurisdiction	Floodplain Ordinance	Natural hazard specific ordinance (stormwater, steep slope, wildfire)		Flood insurance rate map	Acquisition of land for open space and public recreation uses	Building code	Building Code Effectiveness Grading Schedule (BCEGS) Score	Fire Department ISO rating	Site Plan review requirements	Other*	Totals	Grand Totals	Ranking
Bolton	X		X	X	-		-	X	X	-	5	11	H
Buels Gore		-			-	X	-	X		-	2	8	L
Burlington	X	-		X	-	-	-	X	X	-	4	9	L
Charlotte	X	-		X	X	-	-	X	X	-	5	11	H
Essex	X	-		X	-	-	-	X	X	-	4	9	M
Essex Junction	X	-		X	-	-	-	X	X	-	4	7	L
Hinesburg	X	-		X	-	-	-	X	X	-	4	11	H
Huntington	X		X	X	X	-	-	X	X	X	7	16	H
Jericho	X		X	X	X	-	-	X	X	X	7	15	H
Milton	X			X	-	-	-	X	X		4,3	8	L
Richmond	X		X	X	-	-	-	X	X	X	6	12	H
St. George	X	-		X	-	-	-	X	X	-	4	9	M
Shelburne	X	-		X	-	-	-	X	X	-	4	9	M
South Burlington	X		X	X	-	X	-	X	X	X	7	16	H
Underhill	X	-		X	-	-	-	X	X	-	4	9	M
Westford	X		X	X	X	-	-	X	X	-	6	14	H
Williston	X		X	X	X	-	-	X	X	-	6	14	H

Type of Plan, Ordinance or Program / Jurisdiction	Floodplain Ordinance	Natural hazard specific ordinance (stormwater, steep slope, wildfire)	Flood insurance rate map	Acquisition of land for open space and public recreation uses	Building code	Building Code Effectiveness Grading Schedule (BCEGS) Score	Fire Department ISO rating	Site Plan review requirements	Other*	Totals	Grand Totals	Ranking
Winooski	X	-	X	-	-	-	X	X	-	4	9	M
	Scale: 8 or less Low (L); 9 Medium (M); 10 or more High (H)											

**Other special plans may include brownfields redevelopment, disaster recovery, Local Waterfront Redevelopment Plan, Climate Change Adaptation, etc.
***There is no formal county government for Chittenden County or for any county in Vermont; however, regional planning commissions, may comment upon land development proposals that meet state thresholds identified in Vermont's Act 250. https://nrb.vermont.gov/act250-program

Administrative and Technical Capability

The ability of a local government to develop and implement mitigation projects, policies, and programs is contingent upon its staff and resources. Administrative capability is determined by evaluating whether there are an adequate number of personnel to complete mitigation activities. Similarly, technical capability can be evaluated by assessing the level of knowledge and technical expertise of local government employees, such as personnel skilled in surveying and Geographic Information Systems (GIS).

Table 5.2: Administrative and Technical Capabilities[218]

Community Resource or Asset / Jurisdiction	Planner(s) or engineer(s) with knowledge of land development	Engineer/professionals trained in construction practices related to buildings and/or infrastructure	Planners/Engineer(s) with an understanding of natural and/or	Floodplain Manager	Mutual Aid Compacts	Surveyor(s) Building Inspection	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Scientist familiar with hazards or the community	Civil Engineers	Emergency Manager	Grant Writers	Warning systems or services automated callout, sirens, etc.	Totals	Ranking
Bolton	-	-	-	-	-	-	X	-	-	X	-	-	-	2	L
Buels Gore	-	-	-	-	-	-	-	-	-	X	-	-	-	1	L
Burlington	-	-	-	-	-	-	-	-	-	-	-	-	-		
Charlotte	X	X		-	-	-	-	-	-	-	-	X	-	4	L
Essex	X	X	X	-	-	-	-	X	-	X	-	X	-	6	H
Essex Junction	-	-	-	-	-	-	-	-	-	X	-	-	-	-	
Hinesburg	X	-	X	X	-	-	-	X	-	X	-	X	X	6	H
Huntington	-	-	-	-	-	-	-	-	-	-	-	X	X	3	
Jericho	X	X	X	-	-	X	X		-	X	-	-	-	6	H
Milton	-	-	-	-	-	-	-	-	-		-	-	-	-	-
Richmond	X	-	X	X			X	X	-	X	-	X	-	7	H
St. George	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Shelburne	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
South Burlington	X	X	X	-	-	-	X	X	-	X	-	X	-	7	H
Underhill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Westford	X	-	X	-	-	-	X		-	X	-	X	-	5	M
Williston	X	-	-	-	-	-	-	X	-	-		X	-	2	L
Winooski	X	X	X	-	-	-	X	X	-	-	X		X	7	H
CCRPC	X	X	X	--	-	-	X	X	-	-	-	X	-	6	H
Scale: 4 or less Low (L); 5 Medium (M); 6 or more High (H)															

[218] The checkbox (X) indicates that the local government reported that they maintain a staff member for the given function. This table also includes the Chittenden County Regional Planning Commission (CCRPC) which assists these local governments on a daily basis.

Fiscal Capability

The ability of a local government to implement mitigation activities is also associated with the funding available for policies and projects. Funding for such initiatives is often locally based revenue and financing, as well as outside grants. Costs associated with mitigation activities range from staffing and administrative costs to the actual cost of the mitigation project.

Table 5.3: Fiscal Capabilities[219]

Type of Plan, Ordinance or Program / Jurisdiction	Capital Improvements Project Funding	Authority to levy taxes for specific purposes	Fees for water, sewer, gas or electric services	Impact fees for new development	Storm water utility feed	Incur debt through general obligation bonds and/or special tax bonds	Incur debt through private activities	Community Development Block Grant	Other Federal Funding	State funding programs	Public/Private partnership funding sources	Totals	Ranking
Bolton	X	X				X		X	X	X		6	H
Buels Gore								X	X	X		3	L
Burlington													
Charlotte						X		X	X	X	X	5	M
Essex	X	X	X									3	
Essex Junction													
Hinesburg	X	X				X			X			4	L
Huntington	X	X				X			X	X	X	6	H
Jericho	X		X	X		X			X	X	X	7	H
Milton													
Richmond	X		X	X		X		X	X	X		7	H
St. George													
Shelburne													
South Burlington	X		X		X	X		X	X	X	X	8	H
Underhill													
Westford	X	X		X		X	X	X	X	X	X	9	H
Williston	X	X	X	X	X	X				X		7	H
Winooski	X	X	X		X	X			X	X	X	8	H

219 A check in the box (X) indicates that the financial resource was reported to be available in the local jurisdiction for mitigation purposes. This table also includes the Chittenden County Regional Planning Commission (CCRPC) which accesses Federal, State, and other grants to support municipal efforts as well as manages numerous consultants that can provide technical services to the County's municipalities.

CCRPC								**X**	**X**	**X**	**X**	**4**	**L**
Scale: 1-4 less Low (L); 5 Medium (M); 6 or more High (H)													

Program/Organizations Capabilities

The ability of a local government to implement mitigation activities is also associated with the level of participation from entities outside of government, including non-profit organizations, community and civic groups and faith-based organizations. These groups frequently include civic-minded individuals, and organizational missions sometimes include disaster preparedness, response, and recovery as an organizational purpose or project. Community organizations and educational programs can assist with promoting the benefits of hazard mitigation and may provide opportunities for public-private partnerships that leverage local funding through grants and other means.

Table 5.4: Program/Organizations Capabilities[220]

Program/ Organization Jurisdiction	Civic groups serving special community needs*	Ongoing public education or information program	Natural disaster or safety related school programs	StormReady certification	Firewise Communities certification	Public-private partnership initiatives addressing disaster related issues	Other	Totals	Ranking
Bolton									
Buels Gore									
Burlington									
Charlotte	**X**					**X**		**2**	**L**
Essex	**X**	**X**						**2**	**L**
Essex Junction									
Hinesburg		**X**						**1**	**L**
Huntington	**X**	**X**	**X**			**X**	**X**	**5**	**H**
Jericho	**X**	**X**	**X**			**X**		**4**	**H**
Milton									
Richmond	**X**	**X**						**2**	**L**
St. George									
Shelburne									

[220] A check in the box (X) indicates that the program resource was reported to be available in the local jurisdiction for mitigation purposes.

Program/ Organization / Jurisdiction	Civic groups serving special community needs*	Ongoing public education or information program	Natural disaster or safety related school programs	StormReady certification	Firewise Communities certification	Public-private partnership initiatives addressing disaster related issues	Other	Totals	Ranking
South Burlington	X	X				X		3	M
Underhill									
Westford	X	X	X					3	M
Williston		X						1	L
Winooski									
Scale: 2 or less Low (L); 3 Medium (M); 4 or more High (H)									
Local citizen groups or non-profit organizations focused on functional needs populations, etc.									
**E.g., responsible water use, fire safety, household preparedness, environmental education, household, recycling, etc.									

Jurisdictional Capabilities Summary

The capabilities score for each jurisdiction is based solely on the information provided by local officials in response to the Local Capabilities Assessment Worksheet, which varied by municipality. The information from the worksheet survey was incorporated into a qualitative scoring system to provide an overall capability rating of “high”, “medium”, or “low”.

Table 5.5: Chittenden County Capability Assessment Ranking

Jurisdiction	Capability			
	Planning and Regulatory	Administrative and Technical	Fiscal	Education and Outreach
Bolton	High	Low	High	
Buel’s Gore	Low	Low	Low	
Burlington	Low	Low		
Charlotte	High	Low	Medium	Low
Essex	High	High	Moderate	Low
Essex Junction	Low			
Hinesburg	High	High	Low	Low
Huntington	High		High	High

Jurisdiction	Capability			
	Planning and Regulatory	Administrative and Technical	Fiscal	Education and Outreach
Jericho	High	High	High	High
Milton	Low			
Richmond	High	High	High	Low
St. George	Medium			
Shelburne	Medium			
South Burlington	High	High	High	Medium
Underhill	Medium			
Westford	High	Medium	High	Medium
Williston	High	Low	High	Low
Winooski	Low		High	Low
CCRPC				

No matter the strength of mitigation capabilities there is always room for improvement due to constantly changing factors such as population, staffing, financial, and types and magnitudes of hazards. During the assessment, a gap analysis was performed to identify ways capabilities can be expanded and improved to reduce risk. Specific activities that enhance mitigation capabilities are described in each jurisdiction annex. Key areas for improvement include:

- Increases in financial capabilities is necessary to complete a broad range of mitigation actions that will protect life, property, and the environment.
- Increases in public education about natural and human-caused hazards are necessary to better prepare the population, especially vulnerable populations, about hazards, including the future increased severity and frequency of hazards such as flooding.

NFIP Assessment and Continued Compliance

The administration of the National Flood Insurance Program (NFIP) is a key component of jurisdictional hazard management capabilities. The United States Congress established the NFIP with the passage of the National Flood Insurance Act of 1968. Some planning participants partake in the Community Rating System (CRS), which is a part of the NFIP. The CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. This is done by providing flood insurance premium discounts to property owners in communities participating in the CRS program. Credit points are earned for a wide range of local floodplain management activities; the total number of points determines the amount of flood insurance premium discounts to policyholders[221]. None of the participating municipalities currently participate in the CRS.

All municipalities included in the planning process participate and are in good standings in the NFIP. Buel's Gore does not participate in the NFIP and do not have any identified Special Flood Hazard Areas (floodplains). Flood Insurance Rate Map (FIRM) in effect in each community. Additional information on each municipality's NFIP participation is provided in the individual jurisdictional annex.

Flood Insurance Rate Maps (FIRM) were developed by FEMA and show the boundaries of the 100-year and 500-year floods. Eleven of the maps are over 10 years old. Some plan participants have experienced growth since the effective date of their most recent FIRM and this change may not be reflected in the FIRM. This difference may mean that the actual floodplain varies from that depicted on the map.

Table 5.6: NFIP Participation Summary[222]

Jurisdiction	Date of FIRM	Number of Policies	Total Premiums (in dollars)	Total Coverage (in dollars)	Total Number of Claims Since 1978	Value of Claims Paid Since 1978 (in dollars)	Number of Repetitive Loss Properties
Bolton	8/4/2014	13	$14,630	$2,787,700	6	$126,117	0
Buels Gore	*Not Applicable*						
Burlington	7/18/2011	35	$34,842	$10,640,200	14	$110,146	0
Charlotte	7/18/2011	11	$15,524	$3,750,00	5	$135,095	0
Colchester	7/18/2011	37	$21,304	$10,948	61	$970,283	3
Essex Junction	7/18/2011	7	$3470	$1,568,000	0	0	0
Essex	7/18/2011	12	$12,310	$4,109,400	3	$6,877	0
Hinesburg	8/4/2014	3	$1,653	$676,000	3	$3,444	0
Huntington	8/4/2014	21	$3,832	$5,977,500	17	$156,573	2
Jericho	8/4/2014	14	$8,941	$3,239,000	7	$62,628	1
Mitton	7/18/2011	16	$25,900	$3,697,900	23	$298,553	2
Richmond	8/4/2014	51	$72,435	$14,103,300	41	$505,951	6
St. George*	8/4/2014	St. Gorge joined the NFIP in October 2021					
Shelburne	7/18/2011	14	$8835	$3,804,200	5	$117,808	0

221 Federal Emergency Management Agency. (2016, September) *State Hazard Mitigation Planning Key Topics Bulletins: Mitigation Capabilities*. https://www.fema.gov/sites/default/files/2020-06/fema-statemitigation-capabilities-planning-bulletin_09-26-2016.pdf#:~:text=An%20assessment%20of%20state%20mitigation%20capabilities%20is%20essential,efforts%20targeted%20for%20state-level%20and%20%20local%20planning.
222 Federal Emergency Management Agency. (n.d.). *Community Status Book Report Vermont: Community Participating in the National Flood Program*. https://www.fema.gov/cis/VT.pdf

Jurisdiction	Date of FIRM	Number of Policies	Total Premiums (in dollars)	Total Coverage (in dollars)	Total Number of Claims Since 1978	Value of Claims Paid Since 1978 (in dollars)	Number of Repetitive Loss Properties
South Burlington	7/18/2011	16	$7,625	$4,458,000	4	$8,188	0
Underhill	7/18/2011	13	$13,337	$3,782,500	10	$77,287	1
Westford	7/18/2011	1	$241	$42,000	0	0	0
Williston	8/4/2014	11	$6,167	$2,955,000	4	$23,428	0
Winooski	7/18/2011	6	$33,671	$2,225,000	1	$16,236	0
Totals		**281**	**$294,717**	**$78,815,300**	**204**	**$2,618,614**	**15**

Repetitive Loss (RL) and Severe Repetitive Loss (SRL) Properties

For properties to be eligible for an increased cost share in Flood Mitigation Assistance (FMA) funding, the definitions below must apply, as stipulated in the Biggert-Waters Flood Insurance Reform Act of 2012:

- A **repetitive loss property** is a an NFIP insured structure that has at least two paid flood losses of more than $1,000 each in any 10-year period since 1978.

- A **severe repetitive loss property** consists of any NFIP insured property that has met at least one of the following paid flood loss criteria since 1978 regardless of ownership with two of the claim payments occurring within ten years of each other:

    1. Four or more separate claim payments of more than $5,000 each (including building and content payments); or
    2. Two or more separate claim payments (building payments only) where the total of the payments exceeds the current value of the property.

Repetitive Loss and Severe Repetitive Loss Strategy

There are a total of 15 repetitive loss properties within the municipalities participating in the *2022 MJAHMP*. The Towns Huntington (2), Jericho (1), Milton (2), Richmond (6) and Underhill (1) each have repetitive loss properties, as indicated in parentheses. The Town of Colchester, which is not a participating jurisdiction in the 2022 MJAHMP has three RL properties. Additionally, there are not any Severe Repetitive Loss structures in these communities.

Plan participants employ several strategies to reduce the number of RL and SRL properties in their municipalities, including regulatory requirements such as building code enforcement and floodplain and zoning ordinances, comprehensive planning activities including land use planning, and environmental management activities such as open space and natural environment preservation.

These strategies serve to make local municipalities eligible for increased federal cost share for FEMA Flood Mitigation Assistance (FMA) grants. The strategy adheres to the requirements from Title 44 C.F.R. $201.4 (c)(3)(v).

Specific information about NFIP compliance, CRS participation, and NFIP insured structures that have been categorized as Repetitive Loss and Severe Repetitive Loss properties are included in the jurisdiction annexes.

Table 5.7: NFIP- Repetitive Loss Properties by Municipality and Occupancy[223]

Community Name	County Name	Mitigated	Occupancy 1
RICHMOND, TOWN OF	CHITTENDEN COUNTY	YES	SINGLE FMLY
MILTON, TOWN OF	CHITTENDEN COUNTY	NO	SINGLE FMLY
COLCHESTER, TOWN OF	CHITTENDEN COUNTY	YES	SINGLE FMLY
RICHMOND, TOWN OF	CHITTENDEN COUNTY	NO	OTHR-NONRES
RICHMOND, VILLAGE OF	CHITTENDEN COUNTY	YES	SINGLE FMLY
COLCHESTER, TOWN OF	CHITTENDEN COUNTY	YES	SINGLE FMLY
MILTON, TOWN OF	CHITTENDEN COUNTY	NO	2-4 FAMILY
COLCHESTER, TOWN OF	CHITTENDEN COUNTY	NO	SINGLE FMLY
UNDERHILL, TOWN OF	CHITTENDEN COUNTY	NO	SINGLE FMLY
JERICHO, TOWN OF	CHITTENDEN COUNTY	NO	OTHR-NONRES
RICHMOND, TOWN OF	CHITTENDEN COUNTY	NO	SINGLE FMLY
HUNTINGTON, TOWN OF	CHITTENDEN COUNTY	NO	SINGLE FMLY
RICHMOND, TOWN OF	CHITTENDEN COUNTY	NO	SINGLE FMLY
HUNTINGTON, TOWN OF	CHITTENDEN COUNTY	NO	SINGLE FMLY
RICHMOND, TOWN OF	CHITTENDEN COUNTY	NO	SINGLE FMLY

223 VEMA Repetitive Loss Properties Data.

Section 6: Mitigation Strategy

FEMA Local Hazard Mitigation Plan Requirements – Mitigation Strategy

- **§201.6(c)(3)** – [The plan shall include the following:] A *mitigation strategy* that improve these existing tools. policies, programs, and resources, and its ability to expand on and identified in the risk assessment, based on existing authorities, provides the jurisdiction's blueprint for reducing the potential losses.
- **§201.6(c)(3)(i)** – [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.
- **§201.6(c)(3)(ii)** – [The hazard mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008, must also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.
- **§201.6(c)(3)(iii)** – [The hazard mitigation strategy shall include an] action plan, describing how the action identified in paragraph (c)(3)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.
- **§201.6(c)(3)(iv)** – For multi-jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.
- **§201.6(c)(4)(ii)** – [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvements, when appropriate.

2022 HMP Update:

- Updated capability assessments were conducted for all municipalities.

•	Goals and objectives from the 2017 MJAHMP were reviewed and revised to provide streamlined goals to ensure consistency with the CCRPC Regional Strategies, and FEMA mitigation requirements.
•	Mitigation actions were adapted from the 2017 MJAHMP to include additional analysis of progress in mitigation.
•	Updated funding descriptions and requirements were added per the latest FEMA guidance documents and 2018 Vermont State Hazard Mitigation Plan.

Overview of the Mitigation Strategy

The Mitigation Strategy provides the blueprint for the participating municipalities to improve disaster resiliency by lessening vulnerability to identified hazards of concern. Defined Mitigation Goals and Objectives inform the development of appropriate mitigation strategies, or actions and initiatives, designed to avoid, minimize, and mitigate the impacts of natural and manmade disasters on the local population, property, environment and economy in the planning area. Communities strengthen their resiliency by issuing building codes, zoning ordinances, and other regulatory activities. When communities review or update these planning mechanisms, the opportunity exists to identify whether mitigation strategies can be incorporated into policy changes. Such efforts go a long way to ensuring that each jurisdiction will remain resilient when affected by known hazards.

The Mitigation Strategy also supports development of “bricks and mortar” projects that can move Community Lifelines and other assets out of hazard-prone areas or undertake other types of projects that serve to minimize the risk and vulnerability of these assets from specific hazards.

Regional Goals, Regional Strategies, and Municipal Objectives

For the *2022 MJAHMP* update, the term “Mitigation Strategy” (or Strategy) is an all-inclusive term encompassing all elements of this plan that guide the overall purpose of the planning process – to reduce the risk and vulnerability of community assets from multiple hazards. The Strategy is discussed at two separate but interdependent levels. **Regional Goals** are established to provide the vision for reducing or avoiding losses from the identified hazards. **Regional Strategies** are consistent with, and work in conjunction with the Regional Goals to provide a symbiotic framework for implementation of the Mitigation Actions. The **Municipal Objectives** are not required for the *2022 MJAHMP* update but provide a measurable statement that connects a goal to specific actions. If a municipality elects to define specific objectives for this plan update, they are included in the jurisdiction’s annex. The planning structure, proprietary entity, and method of coordination and integration of the Regional Strategies and Goals, and Municipal Objectives are clearly defined.

Table 6.1: Regional Goals and Strategies, and Municipal Objectives

Mitigation Strategy Component	Proprietary Entity	Coordination/ Integration
Regional Goals	**Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan (MJAHMP)**	• Provide general guidelines that explain what the municipalities want to achieve with the plan to reduce or avoid losses from identified hazards. • Broad, policy-type statements that are a long-term Link to Regional Strategies to support implementation of Mitigation Actions identified in the MJAHMP.
Regional Strategies	**Chittenden County Regional Planning Commission/ 2018 Environment, Community, Opportunity, Sustainability (ECOS) Plan**	• Represent an overarching regional vision to protect resources, guide development, and manage sustainable growth. • Provide a framework, in coordination with municipalities, to implement Mitigation Actions identified in the MJAHMP.
Municipal Objectives (not required)	**MJAHMP-Jurisdiction Annexes**	• Defined by a jurisdiction to provide a performance measure for implementing mitigation actions. • Link to a specific Regional Goal to provide a more detailed description of the desired outcome.

Regional Goals

The Chittenden County All-Hazards Mitigation Plan Update Committee (AHMPUC) discussed goals and objectives for this plan at back-to-back meetings on December 15 and 16, 2021. The committee was provided an overview of initial results of the Hazard Identification and Risk Assessments (HIIRAs) and discussed revisions to the 2017 strategy. The AHMPUC felt that in general, the current mitigation strategy was comprehensive and remains applicable to each municipality in the planning area with some minor revisions. Additionally, they agreed the mitigation priorities for the planning area has not changed since the last plan update, but the Goals and Objectives and list of mitigation actions should be streamlined as part of the 2022 plan update.

The committee approved a set of draft goals at the December meetings. Additionally, each jurisdiction was asked to begin developing a set of draft mitigation objectives and actions. As part of follow-up discussions with the CCRPC, a decision was made to develop a set of countywide or regional goals and strategies, followed by individual jurisdiction' objectives and mitigation actions. Each individual jurisdiction will incorporate these objectives and actions in their jurisdictional annex, as appropriate. Following the development of the regional strategy, during December 2021 and January 2022, technical assistance was provided to municipalities to discuss development of new mitigation actions.

The AHMPUC adopted the **Regional Goals** that align with mitigation themes to address identified risks and vulnerabilities. Community officials should consider these goals as they offer opportunities to establish community policies, develop public investment and economic development programs, and validate critical decisions related to development in their communities.

Given the current strengths and weaknesses of regional and municipal mitigation efforts, regional mitigation priorities, and the assessment of the most significant hazards for the county, this Plan presents the following multijurisdictional goals for hazard mitigation planning in Chittenden County.

Table 6.2: *2022 Chittenden County MJAHMP* Regional Goals

GOAL 1	Protect existing and planned municipal infrastructure.
GOAL 2	Protect life and residential and business properties from natural and manmade hazards.
GOAL 3	Promote and enhance opportunities for public education about hazard mitigation.
GOAL 4	Encourage municipalities to formally incorporate their local all-hazards mitigation plan into their comprehensive plan, as well as incorporate proposed mitigation actions into various bylaws, regulations and ordinances, and municipal operating and capital improvement plans.
GOAL 5	Promote appropriate planning for growth with a focus on changing climate and resiliency.

Regional Strategies

As demonstrated in the discussion within this section and in individual jurisdictional annexes, it is the municipalities that carry out numerous efforts as part of their day-to-day operations that fit within the goal categories and serve to mitigate the impacts of various hazards. However, the CCRPC, as an organization formed to provide services to its member municipalities, has identified various programs and technical assistance it can carry out during the five-year period this Plan is in effect to address vulnerabilities to hazards experienced by the county's municipalities.

The following Strategies from the 2017 MJAHMP are continued for the *2022 MJAHMP* update and will guide the plan implementation activities over the next five years:

- **Category A**: Assist municipalities with development of plans, policies, and zoning regulations.
- **Category B**: Promote municipal participation in development and implementation of Tactical Basin Plans.
- **Category C**: Assist municipalities to develop & improve infrastructure.
- **Category D**: Assist municipalities in protecting people, buildings, and facilities where development already exists.
- **Category E**: Assist municipalities in promoting growth in appropriate locations and with transportation infrastructure planning.
- **Category F**: Assist municipalities in meeting standards to minimize required municipal share towards FEMA Public Assistance project costs.

Current Regional Mitigation Actions

It is important to stress that hazard mitigation is carried out at the municipal or state level in Vermont. There is no formal county government nor are there any entities specifically authorized to conduct hazard mitigation at the regional level. Nevertheless, there are some activities carried out by others, including the CCRPC, that aid municipal and state mitigation efforts.

Table 6.3: Regional Activities Aiding Mitigation Efforts for Natural Hazards

Natural Hazard	Current activities by regional entities
Severe Winter Storm	None
Flooding	CCRPC assists municipalities with mapping flood hazard areas and updating zoning bylaws as needed.
Fluvial Erosion	CCRPC assists municipalities with mapping River Corridors and updating bylaws as needed.
Human Infectious Diseases	CCRPC assists municipalities by facilitating communications to/from Vermont Emergency Management, Vermont Agency of Commerce & Community Development and other state & federal agencies which facilitates mitigation actions by municipalities.
Invasive Species	None formally but conservation, academic and recreational interests cooperate in outreach programs. Recently, CCRPC has worked to promote municipal awareness of emerald ash borer mitigation programs.
Severe Rainstorm	CCRPC assists municipalities by maintaining road erosion inventory databases, provides engineering design services and producing data for project implementation tracking so they can meet MRGP or MS4 permit

Natural Hazard	Current activities by regional entities
	requirements. See also discussion of Power Loss & Telecommunications Failure.
Extreme Temperatures	None known.
Wildfire	None known.

Table 6.4: Regional Activities Aiding Mitigation Efforts for Technological Hazards

Technological Hazard	Current activities by regional entities
Major Transportation Incident	The CCRPC, in cooperation with the Vermont Agency of Transportation, implements and manages numerous transportation studies and planning efforts to aid in developing a safe transportation system. Vermont Emergency Management also distributes rapid notice of transportation incidents via the VT-ALERT system. See info at: https://vem.vermont.gov/vtalert
Power Loss	Private utilities trim vegetation and take other measures as needed for mitigation. The public can access data on power outages at VTOutages.com.
Hazardous Materials Incident	CCRPC provides administrative support to the Regional Emergency Management Committee (REMC), formed in early 2022, which is engaged in all-hazard planning in Chittenden County. The State Emergency Response Commission (SERC) and the Statewide Local Emergency Planning Commission (LEPC) maintain coordination with the REMC on HAZMAT specific issues.
Water Service Loss	Champlain Water District and other municipal drinking water systems provide information to their member municipalities and residents.
Gas Service Loss	Unknown. Only one natural gas company in County, VGS.
Telecommunications Failure	Private utilities trim vegetation and take other measures as needed for mitigation.
Other Fuel Service Loss	Rare occurrence. The Vermont Fuel Dealers Association may carry out applicable trainings.
Sewer Service Loss	Rare occurrence. The Green Mountain Water Environment Federation may carry out applicable trainings.
Water Pollution	For several years, CCRPC has facilitated formal regional cooperation among the twelve Municipal Separate Storm Sewer MS4 permittees in the County on two of six required “minimum measures”: public education & outreach and public participation & involvement. Starting in 2015, CCRPC also established its Clean Water Advisory Committee to facilitate stronger municipal understanding of the requirements of the Vermont Clean Water Act and promote municipal participation in development of Tactical Basin Plans. CCRPC also manages engineering firms conducting design or construction oversight services for stormwater treatment projects.

Technological Hazard	Current activities by regional entities
Invasive Species	None formally but conservation, academic and recreational interests cooperate in outreach programs. Recently, CCRPC has worked to promote municipal awareness of emerald ash borer mitigation programs.

Table 6.5: Regional Activities Aiding Mitigation Efforts for Societal Hazards

Societal Hazard	Current activities by regional entities
Crime	Since 1992, Chittenden Unit for Special Investigations. Regional dispatch. In March 2018, the communities of Burlington, Colchester, Milton, South Burlington, Williston, and Winooski formed a new union municipal district, the Chittenden County Public Safety Authority, to work towards providing regional emergency dispatch services. As of March 2022, the authority has fine-tuned cost estimates and is looking to obtain funds for implementation.
Economic Recession	Greater Burlington Industrial Corporation, Lake Champlain Regional Chamber of Commerce and others work to develop a HUD-required "Community Economic Development Strategy" aka CEDS which is incorporated into the Chittenden County "ECOS" (Regional) Plan.
Terrorism	Primarily State and Federal responsibility.
Civil Disturbance	None for mitigation but municipal police departments have mutual-aid response protocol in place.
Key Employer Loss	Greater Burlington Industrial Corporation, Lake Champlain Regional Chamber of Commerce, academic institutions, and others cooperate on job training.

As detailed above, various forms of hazard mitigation are already being carried out at the municipal level. Well-developed, long-standing categories of local, municipal actions that include basic mitigation measures include a) maintenance and upgrades to municipal infrastructure especially transportation & utilities; b) maintenance and updates to local land development regulations, and c) development and updates to municipal comprehensive plans, capital plans, and other related efforts.

Another effective way to achieve mitigation is to simply preclude development in certain areas. Throughout the county there are numerous parcels that are conserved for their scenic beauty, views, farming purposes, cultural and historical significance, recreation, wildlife habitat, and other purposes. In some cases, these overlap with areas vulnerable to hazards such as flooding, fluvial erosion, and wildfire, and/or overlap with corresponding zoning designations that preclude development. Many municipalities dedicate an annual portion of their tax revenue towards conservation/open space funds. In addition, there are several organizations, large and small, in the state that purchase or accept donated conservation easements on key parcels. Major organizations active in the county in this role include, Vermont Housing and Conservation Board, Vermont Land Trust, The Nature Conservancy, Winooski Valley Parks District, Lake Champlain Land Trust, and Vermont River Conservancy and Richmond Land Trust.

Table 6.6: Conserved Land by Municipality[224]

Town Name	Acres	Acres Public or Conserved Land	Percent Public or Conserved Land	Acres of River Corridor	Acres of Public or Conserved Land within River Corridor	Percent of Public or Conserved Land within River Corridor	Acres of Special Flood Hazard Area	Acres of Public or Conserved Land within SFHA	Percent of Public or Conserved Land within SFHA
Bolton	26,982.39	16,307.89	60%	884.04	291.55	33%	618.22	104.58	17%
Buels Gore	3,201.53	1,988.60	62%	0	0	0%	0	0	0%
Burlington	6,776.11	1,288.12	19%	851.77	458.29	54%	1,552.51	901.31	58%
Charlotte	26,505.21	7,801.54	29%	793.18	290.5	37%	292.1	44.98	15%
Colchester	22,255.79	3,988.74	18%	2,006.96	733.64	37%	3,889.82	1,571.72	40%
Essex	22,255.79	1,512.29	7%	1,258.32	117.69	9%	2,634.40	525.27	20%
Essex Junction	2,973.90	514.68	17%	425.32	168.58	40%	417.52	207.7	50%
Hinesburg	25,398.79	5,038.55	20%	754.41	292.74	39%	1,494.90	491.36	33%
Huntington	24,526.57	7,339.81	30%	826.34	127.83	15%	508.42	73.31	14%
Jericho	22,725.65	7,649.01	34%	1,107.30	313.87	28%	1,334.34	361.58	27%
Milton	33,950.20	4,604.20	14%	1,693.03	527.55	31%	3,886.74	1,658.20	43%
Richmond	21,063.02	3,872.79	18%	1,470.52	122.07	8%	2,114.80	190.98	9%
Shelburne	15,984.69	4,999.67	31%	516.82	233.36	45%	1,775.79	902.31	51%
South Burlington	10,597.64	1538.58	15%	539.17	86.81	16%	699.24	114.55	16%
St. George	2,353.59	4.25	0%	0	0	0%	39.84		0%
Underhill	32,820.98	10,357.60	32%	628.79	60.91	10%	765.44	55.1	7%
Westford	25,044.46	1,536.22	6%	855.84	28.36	3%	507.29	8.39	2%
Williston	19,894.39	4,625.80	23%	1,339.24	229.51	17%	1,918.84	365.83	19%
Winooski	941.96	183.58	19%	189.77	109.71	58%	179.89	110.77	62%
County	347,804.5 3	85,151.92	24%	16,140.8 2	4,192.97	26%	24,630.1 0	7,687.94	31%

Review and Evaluation of a Range of Mitigation Actions

Building on the information from the risk assessment, existing capabilities, and the status of previous actions identified in the county's previous *MJAHMP*, the AHMPUC reviewed and analyzed a comprehensive range of mitigation actions and projects. Each jurisdiction was

224 CCRPC, comparable data set across municipalities. See individual municipal AHMPs for up-to-date figures.

responsible for the development of its mitigation actions. In general, separate jurisdictional meetings were conducted between December 2021 and January 2022 to discuss and begin formalizing the set of new mitigation actions for inclusion in the *2022 MJAHMP*. Each jurisdiction was provided a copy of the FEMA resource *Mitigation Ideas: A Resource for Reducing Risk for Natural Hazards* (January 2013) to expand the scope of activities for consideration. The comprehensive range of potential activities included in *Mitigation Ideas* enabled the AHMPUC to analyze and evaluate different mitigation measures, including a mixture of structural and non-structural activities.

FEMA identifies four primary types of mitigation actions to reduce long-term vulnerabilities: local plans and regulations; structure and infrastructure; natural systems protection; and public education and awareness. Additional details about these types of actions are shown in Table 6.7. These actions are also traditionally eligible for hazard mitigation and other types of funding.

Table 6.7: Mitigation Actions/Techniques

Mitigation Actions/Techniques	
Local Plans and Regulations	
Definition	**Examples**
These actions include government authorities, policies, or codes that encourage risk reduction.	• Comprehensive plans • Land use ordinances • Subdivision regulations • Development review • Building codes and enforcement • NFIP Community Rating System (CRS) participation • Capital improvement programs • Open space preservation • Stormwater management regulations and master plans Community wildfire protection plans, fuels management, and fire breaks
Structure and Infrastructure Projects	
Definition	**Examples**
These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. These actions also include constructing new structures to reduce the impact of hazards. **This could apply to public or private structures as well as critical facilities and infrastructure.**	• Acquisitions and elevations of structures in flood-prone areas • Utility undergrounding • Structural retrofits (e.g., shelters) • Floodwalls and retaining walls • Detention and retention structures • Culverts Safe rooms
Natural Systems Protection	
Definition	**Examples**

These are actions that minimize damage and losses while preserving or restoring the function of natural systems.	• Sediment and erosion control • Stream corridor restoration • Forest management • Conservation easements • Wetland restoration and preservation
Public Education and Awareness	
Definition	**Examples**
These are long-term, sustained programs to inform and educate the public and stakeholders about hazards and mitigation options. This can also include training.	• Radio or television spots • Websites with maps and information • Social media • Real estate disclosure • Presentations to school groups or neighborhood organizations • Mailings to at-risk populations and residents in hazard-prone areas • StormReady certification Participation in the FireWise USA program

Status of 2017 Regional Mitigation Actions

A thorough review of mitigation actions identified in the *2017 MJAHMP* was conducted to determine the effectiveness of the action and the progress made to date. Each participating jurisdiction as well as the CCRPC was asked to review and update the status of each action to determine if:

- the action was completed.
- the action is no longer applicable; or,
- it should be moved forward and included in the 2022 Plan.

The updated status of previous mitigation actions is provided in the individual jurisdiction annexes.

Table 6.8: Status of Previous Mitigation Actions from the 2017 MJAHMP

Chittenden County RPC	Action #	Title of Project	Hazard(s)	2022 Status Update / Comments
CCRPC	2017-A-1	Flood Resilience Planning	SR, F, FE, WP	Excellent progress: Have assisted several towns with drafting of required flood resiliency chapters in municipal plans.

Chittenden County RPC	Action #	Title of Project	Hazard(s)	2022 Status Update / Comments
CCRPC	2017-A-2	River Corridor Protection	SR, F, FE, WP	Some progress: City of South Burlington and Town of St. George have adopted RC Bylaws.
CCRPC	2017-A-3	Water Quality Bylaws	SR, F, FE, WP	Some progress: Some municipalities have strengthened water quality protections.
CCRPC	2017-A-4	Storm Water Master Planning	SR, F, FE, WP	Good progress: Storm Water Master Plans completed for towns of Jericho, Milton, Richmond and Underhill. Although not called for in the 2017 Plan, nine municipalities regulated by an MS4 permit completed Phosphorus Control Plans in early 2021 which will help to reduce stormwater runoff, erosion, sedimentation and phosphorus loading.
CCRPC	2017-A-5	Private Green Infrastructure	SR, F, FE, WP	Good progress: On behalf of the municipalities of Milton, Colchester, Winooski, Burlington, Essex, Essex Junction, Williston, South Burlington and Shelburne, managed the Rethink Runoff program (www.rethinkrunoff.org) to educate and provide opportunities for residents to learn about stormwater impacts and potential GSI solutions such as rain barrels and rain gardens.
CCRPC	2017-B-1	Project Mapping	SR, F, FE, WP	Good progress: Assisted VANR staff by providing information on municipal priority projects for the completed updates to Tactical Basin Plans for the Lamoille River, Northern Lake Champlain and the Winooski River.
CCRPC	2017-B-2	Project Prioritization	SR, F, FE, WP	Good progress: Assisted VANR staff by providing information on municipal priority projects for the completed updates to Tactical Basin Plans for the Lamoille River, Northern Lake Champlain and the Winooski River.
CCRPC	2017-C-1	Municipal Roads General Permit	SR, F, FE, WP	Excellent progress: Assisted all municipalities with completing required inventories of hydrologically connected road segments, updating inventory data as needed on an annual basis, submitting required annual reports and

Chittenden County RPC	Action #	Title of Project	Hazard(s)	2022 Status Update / Comments
				submitting the required Road Stormwater Management Plan to DEC.
CCRPC	2017-C-2	Transportation Infrastructure Mitigation Project Scoping	SR, F, FE, WP	Excellent progress: Have assisted most all our municipalities with using CCRPC UPWP funds or accessing grant funds to develop conceptual designs and construction cost estimates for upgrades or replacements for ditches, culverts, outfalls, etc.
CCRPC	2017-D-1	Reduce Future Flooding Risk for Existing Development	F, FE	Some progress: Have provided advice to a few municipalities regarding strategies for buyout or elevation of at-risk properties.
CCRPC	2017-D-2	Create New Flood Storage Capacity	F, FE	No progress: No requests received from municipalities.
CCRPC	2017-E-1	ECOS Strategy 3.2.2.: Strive for 80% of new development in areas planned for growth, Action Item 1 Invest in Areas Planned for Growth	ER	Excellent progress: CCRPC has used two EPA grants and one recent grant from the Vermont Agency of Commerce & Community Development to assist in redevelopment of numerous properties for housing, commerce, recreation & transportation in several municipalities. Additionally, for 2017 through 2021, more than 80% of new development in each year has been in areas planned for growth.
CCRPC	2017-E-2	ECOS Strategy 3.2.2.: Strive for 80% of new development in areas planned for growth, Action Item 6:	ER	Excellent progress: The CCRPC adopted its Metropolitan Transportation Plan as part of the ECOS update in June 2018. The MTP anticipates and allocates 74% of future funding for maintenance and operations expenses for the existing transportation system. The remaining funds are distributed between transit, bike and pedestrian, interstate, other roadway improvements and a variety of already committed to projects.

Chittenden County RPC	Action #	Title of Project	Hazard(s)	2022 Status Update / Comments
		Metropolitan Transportation Investments		From federal fiscal years 2017 through 2021 over $220 million (will update this # by late March) was spent in Chittenden County on priority projects listed in the ECOS/Metropolitan Transportation Plan and the Transportation Improvement Program (TIP). The largest area of investment was in paving. Other important categories of projects were safety, traffic operations, and bridge preservation.
CCRPC	2017-F-1	Facilitate municipal adoption of four Base standards for ERAF		Excellent progress: 1. 19 of 19 municipalities have adopted LEMPs 2. 18 of 19 municipalities have adopted the new VTRANS 2019 Town Road & Bridge Standards 3. 18 of 19 municipalities participate in the NFIP. Buels Gore has no mapped floodplain. 4. 19 of 19 municipalities have adopted their local AHMP which is annexed to the 2017 Multi-Jurisdictional AHMP.
CCRPC	2017-F-2	Facilitate municipal adoption of bonus Base ERAF measures		Good progress: Thirteen of the 19 communities in the County currently have early adopter designation pursuant to current ERAF requirements. Additionally, both the City of South Burlington and the Town of St. George have adopted River Corridor Bylaws.
Acronym Key:	Dam Failure: DF			
	Economic Recession: ER			
	Extreme Temperatures: ET			
	Flood: F			
	Fluvial Erosion: FE			
	Human Infectious Disease: HID			
	Invasive Species: IS			
	Severe Rainstorm: SR			
	Severe Winter Storm: SWS			
	Water Pollution: WP			
	Wildfire: WF			

Additionally, as part of previous planning period (2017-2022) activities with the assistance of the CCRPC each of the participating municipalities integrated were appropriate the mitigation actions outlined in the previous plan into their current Town's plan. A similar process will be implemented as part of plan integration activities during the 2022-2027 planning period.

New Regional Mitigation Actions

In addition to the actions carried forward from previous plans, each jurisdiction has identified a minimum of two new mitigation actions for each natural hazard to include in this plan update. A summary of the 2022-2027 new regional mitigation actions is provided in this section; the specific jurisdictional mitigation actions are provided in the respective jurisdictional annex. Actions were developed using the methods of prevention, property protection, natural resource protection, structural projects, emergency services, and public education and awareness.

Table 6.9. 2022 Prioritized Regional Mitigation Actions, CCRPC

Category A: Assist municipalities with development of plans, policies, and zoning regulations							
Action Number Proposed Action	**Lead Agency/ Department(s)**	**Risk Reduction Benefit**	**Hazard(s) Addressed**	**Estimated Cost**	**Funding Source**	**Time Frame**	**Priority Ranking**
	CCRPC and Municipalities	Protect public buildings, strengthen existing and new critical facilities and reduce risk to public health, safety and welfare. In terms of long-term effectiveness, the actions outlined above are the most appropriate because it is at the municipal level that regulations affecting land development (i.e. location and nature of newly-built buildings and infrastructure) are promulgated and enforced. Through these measures, vulnerabilities to the hazards outlined above most effectively reduced.	SR, F, FE, WP, WF, SWS, SR, DF	Medium: $10,000 to $100,00	Primarily various Federal and State grants; municipal funds only if sufficient.	2022-2027	Medium
	Action A-1: Flood Resilience Planning: Provide assistance with drafting of required Flood Resiliency chapters in municipal plans including language and maps regarding fluvial erosion/river corridors and flooding, and references to the municipality's All Hazard Mitigation Plans and Vermont DEC's Tactical Basin Plans.						
	Action A-2: River Corridor Protection: As requested, provide assistance with mapping and development of regulatory language to preclude or minimize development within mapped River Corridors consistent with the model bylaws promoted by the State of Vermont.						

	Action A-3: Water Quality Bylaws: Provide outreach, mapping and technical assistance to municipalities concerning adoption of zoning bylaws and other measures to improve water quality. Promote the use of Low Impact Development principles and Green Stormwater Infrastructure techniques in municipal Land Development Regulations to restore or maintain pre-development ecological and hydrological function through the protection, enhancement, or mimicry of natural processes.						
Category B: Promote municipal participation in development and implementation of Tactical Basin Plans							
Action Number Proposed Action	**Lead Agency/ Department(s)**	**Risk Reduction Benefit**	**Hazard(s) Addressed**	**Estimated Cost**	**Funding Source**	**Time Frame**	**Priority Ranking**
	CCRPC and Municipalities	As noted in the discussion on Water Pollution, Tactical Basin Plans are the primary vehicle used to identify needed projects on a watershed basis and by extension in individual municipalities. In addition to Federal grants, there is the opportunity of the State's Clean Water Fund and various Agency of Transportation grant programs to which municipalities can apply for funds to implement projects which include road drainage improvement projects, culvert and bridge upgrades, floodplain restoration projects, wetland improvement projects, streambank plantings, stormwater infrastructure, etc. Implementation of these projects will reduce the vulnerabilities to the hazards identified above.	SR, F, FE, WP, WF, SWS, DF	Low: Less than $10,000	Vermont DEC	2022-2027	Medium
	Action B-1: Project Prioritization Process: CCRPC will assist in prioritizing Basin Plan projects in conjunction with ANR and municipalities in concert with Tactical Basin Planning. Lamoille River (Monitoring & Assessment-2018-2019): towns of Milton, Colchester, Jericho, Underhill, Westford and Essex. Winooski River (Planning-2017-2018; Monitoring & Assessment-2020-2021): Burlington, Colchester, Essex, Hinesburg, Huntington, Jericho, Shelburne, South Burlington, Richmond, Williston and Winooski. Northern Lake Champlain (Monitoring & Assessment-2016-2017; Planning-2018-2019): Burlington, Colchester, Essex, Hinesburg, Milton, Richmond, Shelburne, South Burlington and Westford. Action B-2: Project Development & Implementation CCRPC will assist municipalities and other entities in the scoping, refinement and sourcing of funding for water quality improvement projects in the non-transportation sector.						
	Action B-2: Project Development & Implementation: CCRPC will assist municipalities and other entities in the scoping, refinement and sourcing of funding for water quality improvement projects in the non-transportation sector.						

Category C: Assist municipalities to develop & improve municipal infrastructure							
Action Number Proposed Action	**Lead Agency/ Department(s)**	**Risk Reduction Benefit**	**Hazard(s) Addressed**	**Estimated Cost**	**Funding Source**	**Time Frame**	**Priority Ranking**
	CCRPC and Municipalities	In addition to the grants discussed in Strategy #2, the State has established the Clean Water Fund and other sources to enable implementation of needed projects addressing erosion and damages caused by the hazards noted above. Implementation of projects noted above, on a consistent annual basis, will slowly but surely build resiliency of each municipality's road infrastructure.	SR, F, FE, WP, WF, SWS, SR	Medium: $10,000 to $100,00	Primarily various Federal and State grants; municipal funds only if sufficient;	2022-2027	Medium
	Action C-1: Municipal Roads General Permit (MRGP) & Municipal Separate Storm Sewer System (MS4) Permit Assist municipalities with compiling & updating existing inventories of stormwater infrastructure, stream geomorphic information, culvert inventories, road erosion inventories and capital budgets, to assist in developing implementation priorities under the municipal roads general permit and the MS4 permit including annual updates to the MRGPs required Implementation Table and for MS4s, the Flow Restoration Plans and Phosphorus Control Plans.						
	Action C-2: Transportation Infrastructure Mitigation Projects Assist municipalities with accessing funds to develop conceptual design & construction cost estimates for transportation infrastructure upgrade or replacement such as culverts, bridges, ditches, grading, etc. to reduce damages from hazard events. Assist with securing grants and other funding sources for implementation.						
	Action C-3: Integration of stormwater treatment with transportation improvements Assist municipalities with the scoping and design of needed stormwater treatment practices with ongoing transportation planning efforts such as intersection improvements, bike lanes, recreation paths and sidewalks.						
	Action C-4: Promotion of Vermont Transportation Resilience Planning Tool and Reducing Repeat Damage Tool Educate municipalities on how to use these tools which identify potential mitigation measures and offers cost-estimates for different improvements. See https://vtrans.vermont.gov/planning/transportation-resilience						

Category D: Assist municipalities in protecting people, buildings and facilities where development already exists							
Action Number Proposed Action	**Lead Agency/ Department(s)**	**Risk Reduction Benefit**	**Hazard(s) Addressed**	**Estimated Cost**	**Funding Source**	**Time Frame**	**Priority Ranking**
	CCRPC and Municipalities	Although only a few types of these projects may be implemented over the next few years, it is worthwhile to provide this assistance to municipalities. That is because such projects clearly help to avoid damages by either moving structures away from hazards or storing flood waters which would otherwise threaten people,	SR, F, FE, WP, WF, SWS, SR, DF	Medium: $10,000 to $100,00	Primarily various Federal and State grants; municipal funds only if sufficient;	2022-2027	Medium

		buildings and infrastructure.					
	Action D-1: Reduce Future Flooding Risk for Existing Development Assist municipalities with identifying vulnerable and/or repetitively damaged structures and provide assistance in securing assistance or funding to either a) elevate properties above BFE, b) relocate structures or c) buying out structures						
	Action D-2: Create New Flood Storage Capacity Assist municipalities in identifying and planning for locations where new flood storage capacity may be created. These opportunities could include creating parks and other open space in vulnerable locations, replacing a vertical wall along a river bank with a more gradual slope to create more room in the river channel for rising water, creating a shallow depression in the lawn that can accommodate inundation, or redesigning buildings to enable the first floor or basement to flood rather than armoring the buildings to repel rising waters.						
Category E: Assist municipalities in promoting growth in appropriate locations and with transportation infrastructure planning							
Action Number Proposed Action	**Lead Agency/ Department(s)**	**Risk Reduction Benefit**	**Hazard(s) Addressed**	**Estimated Cost**	**Funding Source**	**Time Frame**	**Priority Ranking**
	CCRPC and Municipalities	This strategy represents a key mechanism to promote development in appropriate areas which make sense from a land-use and transportation perspective but also indirectly avoid investments in areas vulnerable to hazards. This strategy also explicitly details the integration between this AHMP and the County's Regional Plan.	All ER, KEL	Medium: $10,000 to $100,00	Primarily various Federal and State grants; municipal funds only if sufficient;	2022-2027	Medium
	Action E-1: ECOS Strategy 3.2.2 Strive for 80% of new development in areas planned for growth, which amounts to 15% of our land area. Implement Action Item 1: <u>Invest in Areas Planned for Growth especially</u> a. Establish wastewater, water infrastructure, public transit, and bike/pedestrian facilities in areas currently developed and/or planned for growth. Target reuse, rehabilitation, redevelopment, infill, and brownfield investments to area currently developed and/or planned for growth.						
	Action E-2: ECOS Strategy 3.2.2 Strive for 80% of new development in areas planned for growth, which amounts to 15% of our land area. Implement Action Item 1: Implement Action Item 6: <u>Metropolitan Transportation Plan Investments especially:</u> a. Adequately fund the maintenance and preservation of our existing transportation assets including roads, bridges, rail, transit, walking/biking facilities, and transportation demand management (TDM) programs and facilities. New transportation system investment should focus on the highest priority transportation projects as detailed in the ECOS/Metropolitan Transportation Plan (MTP) Project List. In the next five years, these projects will primarily be those that are included in the Transportation Improvement Program (TIP), as may be amended. The TIP projects are considered FUNDED VITAL PROJECTS for the purposes of the Comprehensive Economic Development Strategy (CEDS).						
<u>Category F: Assist municipalities in meeting standards to minimize required municipal share towards FEMA Public Assistance project costs</u>							

<table>
<tr><th rowspan="4">Action Number Proposed Action</th><th>Lead Agency/ Department(s)</th><th>Risk Reduction Benefit</th><th>Hazard(s) Addressed</th><th>Estimated Cost</th><th>Funding Source</th><th>Time Frame</th><th>Priority Ranking</th></tr>
<tr><td>CCRPC and Municipalities</td><td>This strategy represents a small but ongoing task for CCRPC. Achievement of a high ERAF score directly saves municipalities money in the event of Federally declared disaster.</td><td>All-Hazards for which FEMA could provide PA funds</td><td>Low: Less than $10,000</td><td>EMPG grants and DCED funds to CCRPC;</td><td>2022-2027</td><td>Medium</td></tr>
<tr><td colspan="7">Action F-1: Facilitate municipal adoption of four Base standards for ERAF: The State has incentivized flood resilience planning through the Emergency Relief and Assistance Funds (ERAF) program. There are a number of steps a municipality can take to improve the local match requirement for FEMA post-disaster relief funds. Generally, in the event of a Federal-disaster declaration FEMA covers 75% of the cost of “Public Assistance” projects, typically repairs to roads and culverts and debris cleanup. The remaining 25% must be matched by the State and municipal government. Four requirements are needed for the State to provide half of that requirement, 12.5% match assistance.

CCRPC staff will annually assist, upon request, municipalities that need assistance in completion of these benchmarks, primarily updating the text and subsequent adoption of the annual LEMP.</td></tr>
<tr><td colspan="7">Action F-2: Facilitate municipal adoption of bonus ERAF measures Currently, the State of Vermont will provide an extra 5% match for an overall total of a 17.5% match contribution if one of the following is met:

a) receive ‘early adopter status’ for having strong municipal water quality buffers and floodplain regulations,
b) receive FEMA’s Community Rating System (CRS) designation and prohibit structures in Flood Hazard Areas; or
c) Adopt the following three measures, 1) a River Corridor Overlay for all streams and rivers draining over 2 square miles, 2) a river corridor setback of 50’ from top of bank for streams draining under 2 square miles that cannot be waived, and 3) a minimum regulatory requirement for River Corridors that are at least as restrictive as those outlined in the ANR Model River Corridor bylaws in effect at the time of adoption.</td></tr>
</table>

New Municipal Mitigation Actions

A strong mitigation strategy includes an analysis of actions and projects that are based on a jurisdiction’s risk, vulnerabilities, and community priorities. These actions should represent a comprehensive range of mitigation alternatives that address the vulnerabilities to the hazards that the jurisdictions determine are most important.

Each participating jurisdiction updated its list of mitigation actions based on the review of its risk assessment, existing capabilities, and status of action items in the 2017 HMP. The actions include community-specific details from a comprehensive range of action item categories and are included in each jurisdiction annex.

Table 6.10 shows the number of each type of FEMA-identified primary action item types. This range of projects demonstrates how planning participants are dedicated to taking a multifaceted approach to risk reduction.

Table 6.10: Number of Types of Action Items Selected by Participants [Pending Completion of Jurisdictional Annexes]

Local Plans and Regulations	Structure and Infrastructure Projects	Natural Systems Protection	Public Education and Awareness Programs
	18		

Mitigation Approach

In developing and ranking the 2022 mitigation actions, the AHMPUC elected to use the FEMA recommended Social, Technical, Administrative, Political, Legal, Economic and Environmental (STAPLE/E) evaluation criteria tool as outlined in the *FEMA Local Mitigation Planning Handbook* (March 2013). This process was used to help ensure that the most equitable and feasible actions would be undertaken based on a jurisdiction's capabilities. Through discussion and self-analysis, each jurisdiction used the STAPLE/E criteria when considering and prioritizing mitigation actions. Only actions that satisfied the STAPLE/E criteria to the satisfaction of the jurisdiction and had the potential to reduce vulnerability to hazards were included in the Plan.

The STAPLE/E evaluation method uses seven criteria for evaluating a mitigation action: social, technical, administrative, political, legal, economic, and environmental. Within each of these criteria are additional considerations that may call upon the hazard risk assessment and other sources of information for evaluation.

Table 6.11: STAPLE/E Evaluation Criteria for Mitigation Actions[225]

(S) Social	
Definition	**Considerations**
The public must support the overall mitigation implementation strategy and specific mitigation actions. The mitigation action is evaluated in terms of community acceptance and impact on the population.	**Community Acceptance:** will the action disrupt housing or cause the relocation of people? Is the action compatible with present and future community values? **Impact on Population:** will the proposed action adversely affect one segment of the population?
(T) Technical	
Definition	**Considerations**

[225] Federal Emergency Management Agency. (2011, October 1). *Local Mitigation Plan Review Guide*. https://www.fema.gov/sites/default/files/2020-06/fema-local-mitigation-plan-review-guide_09_30_2011.pdf

It is important to determine if the proposed action is technically feasible, will help to reduce losses in the long-term, and has minimal secondary impacts. This category evaluates whether the action is a whole or partial solution, or not a solution at all.	**Technical Feasibility:** how effective is the action in avoiding or reducing future losses? **Long-Term Solution:** does the action solve the problem or only a symptom? **Secondary Impacts:** will the action create more problems than it solves?
(A) Administrative	
Definition	**Considerations**
This category examines the anticipated staffing, funding, time, and maintenance requirements for the mitigation action to determine if the jurisdiction has the personnel and administrative capabilities to implement the action or whether outside help will be necessary.	**Staffing:** does the jurisdiction have the capability (staff, technical experts, and training) to implement the action? **Funding Allocated:** does the jurisdiction have the funding to implement the action or can it readily be obtained? **Time:** can the action be accomplished in a timely manner? **Maintenance/Operations:** can the community provide the necessary maintenance? it is important to remember that most federal grants will not provide funding for maintenance.
(P) Political	
Definition	**Considerations**
This category considers the level of political support for the mitigation action.	**Political Support:** is there political support to implement and maintain these actions? Have political leaders participated in the planning process so far? **Local Champion or Proponent:** is there a respected community member willing to help see the action to completion? **Public and Stakeholder Support:** is there enough public support to ensure the success of the action? Have all stakeholders been offered nan opportunity to participate in the planning process?
(L) Legal	
Definition	**Considerations**

Whether the jurisdiction has the legal authority to implement the action of whether the jurisdiction must pass new laws or regulations is important in determining how the mitigation action can be best carried out.	**Existing Local Authority:** are proper laws, ordinances, and resolutions in place to implement the action? **Political Legal Challenge:** is there a technical, scientific, or legal basis for the mitigation action (i.e., does the mitigations "fit" the hazard setting)? Are there any potential legal consequences? Is the action likely to be challenged by stakeholders who may be negatively affected?
(E) Economic	
Definition	**Considerations**
Economic considerations must include evaluation of the present economic base and projected growth. Cost-effective mitigation actions that can be funded in current or upcoming budget cycles are more likely to be implemented than actions requiring general obligation bonds or other instruments that would incur long-term debt to a community.	**Benefits of Action:** what financial benefits will the action provide? **Cost of Action:** does the cost seem reasonable for the size of the problem and the likely benefits? What burden will be placed on the tax base or local economy to implement this action? **Contribution to Economic Goals:** does the action contribute to community economic goals, such as capital improvements or economic development? **Outside Funding Required:** are there currently sources of funding that can be used to implement the action? Should the action be considered "tabled" for implementation until outside sources of funding are available?
(E) Environmental	
Definition	**Considerations**
The impact on the environment is an important consideration because of public desire for sustainable and environmentally healthy communities. Also, statutory considerations, such as the National Environmental Policy Act (NEPA), need to be kept in mind when using federal funds.	**Impact on Land/Water Bodies:** how will this action impact land/water? **Impact on Endangered Species:** how will this action impact endangered species? **Impact on Hazardous Materials and Waste Sites:** how will this action impact hazardous materials and waste sites? **Consistency with Community Environmental Goals:** is this action consistent with community environmental goals? **Consistency with Federal Laws:** is the action consistent with federal laws, such as NEPA?

In addition, the anticipated level of cost effectiveness of each measure was a primary consideration when developing mitigation actions. Because mitigation is an investment to reduce future damages, it is important to select measures for which the reduced damages over the life of the measure are likely to be greater than the project cost. For structural measures, the level of cost effectiveness is primarily based on the likelihood of damages occurring in the future, the severity of the damages when they occur, and the level of effectiveness of the selected measure. Although detailed analysis was not conducted during the mitigation action development process, these factors were of primary concern when selecting measures. For those measures that do not result in a quantifiable reduction of damages, such as public education and outreach, the relationship of the probable future benefits and the cost of each measure was considered when developing the mitigation actions.

As a result of this exercise, priority was assigned to each mitigation action by marking them as High (H), Moderate (M), or Low (L). These categories were defined as:

- **Low:** The action has the potential to reduce vulnerability to hazards and based on one to two STAPLE/E criteria and is feasible and important for the jurisdiction. The action should be implemented as funding becomes available. Projected timeline for completion is five or more years.

- **Medium:** The action has the potential to reduce vulnerability to hazards and based on three to four STAPLE/E criteria, is feasible and important for the jurisdiction. Its implementation is not as urgent as a high priority action item and can be implemented in the long-term. Projected timeline for completion is three to five years.

- **High:** The action has the potential to reduce vulnerability to hazards and based on five or more STAPLE/E criteria and is feasible and important for the jurisdiction. It is especially important to the jurisdiction to implement in the short-term and as quickly as possible. Projected timeline for completion is one to two years.

Each of the actions are numbered in the action plans and listed in order of their prioritization (High, Medium, or Low). The actions that were brought forward from the 2017 plan are listed first in the table under their original strategy number, combined with the year that they were developed. The new actions for the 2022 new planning cycle follow the previous actions that were retained in the Plan.

To ensure that each identified activity is implemented, each action item includes information on the expected timeline and the coordinating agency or position. Upon implementation, the coordinating agency may look to partner with other organizations for resources and technical assistance.

Mitigation Action Plan for Implementation

The Mitigation Action Plan for Implementation identifies short and long-term action items developed based on hazard data collection and research, and the public participation process, including the use of a community survey. Mitigation actions may be considered for funding through federal, state, and local funding sources. Through a series of jurisdictional meetings, conference calls, and e-mail exchanges, all municipalities (municipalities) participated in the development and review of the local Mitigation Action Plan for Implementation.

Incorporation into Existing Planning Mechanisms

The primary mechanism for integration of the mitigation plan requirements is through each jurisdiction's comprehensive municipal planning process and its day-to-day municipal operations, especially its public works functions. Each municipality in Chittenden County has adopted a plan (commonly called a town plan, municipal plan, development plan or comprehensive plan) that is either approved by the voters or the governing body. These plans are also reviewed and approved by the Chittenden County Regional Planning Commission. By Vermont statute, municipal plans – as well as the Chittenden County Regional Plan – must be re-adopted at least every eight years after a public review and comment process.

Each of the municipalities will be referring to and integrating the hazard mitigation plan into their municipal plans when they are updating their municipal plans prior to plan expiration. The municipal plan update will be led by the Planning Commission, who will review this plan and determine those mitigation actions/strategies/goals that should be included in the municipal plan.

Another common potential planning goal is to foster "open space" planning, where the municipality engages in a public planning process to identify key natural, scenic, historical, and other areas that should not be developed. In addition, some municipalities have tax revenues or municipal line items dedicated to purchasing land (fee simple or easement) for conservation or open space purposes.

A FEMA planning requirement also includes discussion of how the AHMJP will be integrated into other county and municipal planning mechanisms. These would include capital improvement plans, zoning bylaws, subdivision regulations, and other miscellaneous regulations and ordinances. All of Chittenden counties' municipalities have zoning bylaws and various municipal regulations and ordinances. The existing zoning restrictions on development in hazard areas will apply to all new structures in these hazard areas. In May 2010, the state Legislature passed Act 110 which requires the Agency of Natural Resources to offer municipalities with grants or pass-through funding to adopt shoreland and River Corridor best management practices in local zoning bylaws. Except for Bolton, Buel's Gore, Charlotte, and St. George, all the county's municipalities have an annual capital improvements budget, although those with relatively low tax bases may have difficulty funding capital purchases of significant size.

Each of the municipalities will incorporate the mitigation actions outlined in this plan into the municipal plan during the next plan update process in 2022. The municipal plan update will be led by the Planning Commission, who will review this plan and determine those mitigation actions/strategies/goals that should be included in the town plan. The dates (Year) for each municipal plan update have been added in the respective municipal annex.

Implementation Resources and Funding Opportunities

Determining current and/or potential implementation resources and funding opportunities for each identified action item is a vital part of the mitigation strategy planning process. By exploring, identifying, and designating funding sources now, municipalities are poised to complete identified action items as implementation and funding opportunities arise.
Under 44 CFR §201.6, local governments must have a FEMA-approved local mitigation plan in order to apply for and/or receive hazard mitigation project grant funds for the following federal Hazard Mitigation Assistance (HMA) programs:

- Hazard Mitigation Grant Program (HMGP)
- Building Resilient Infrastructure and Communities (BRIC)
- Flood Mitigation Assistance (FMA)
- Repetitive Flood Claims (RFC)
- Severe Repetitive Loss (SRL)

Figure 6.1: FEMA HMA Grant Funding Programs

Mitigation activities can and should be implemented through a variety of funding streams. FEMA funding sources, including the Hazard Mitigation Grant Program (HMGP), the Building Resilient Infrastructure and Communities (BRIC) program, the Flood Mitigation Assistance (FMA) program, and Sections 404 and 406 Hazard Mitigation Funding tend to be heavily relied on for mitigation action completion. However, it is important to research and leverage other available funding opportunities and not limit funding sources to FEMA assistance programs. Funding opportunities may include other federal agencies, state, local, and tribal programs, as applicable, or private funding. In addition to funding, mitigation implementation resources such as regulatory and technical assistance are available to assist municipalities in completing action items and mitigation integration into planning and resilience efforts. A detail list of potential implementation and funding resources is provided in Appendix F.

In addition to the sources identified in this Plan, Coronavirus (COVID-19) relief funds were distributed by the United States Congress to federal, state, and local government agencies, nonprofit organizations, and individuals in 2020 and 2021. The main funding programs were the Coronavirus Aid, Relief, and Economic Security (CARES) Act (2020), the Coronavirus Response and Consolidated Appropriations Act (2021), and the American Rescue Plan Act (ARPA) (2021)[226]. These funds have a broad range of allowable expenses, including supporting public health expenditures, replacing lost public sector revenue, and investing in water, sewer, broadband, and cybersecurity infrastructure. Within these overall categories, recipients have been able to develop and implement eligible projects and activities to mitigate hazard risks and vulnerabilities.

[226] USA Spending. (2021, September 20). *The Federal Response to COVID-19*. https://www.usaspending.gov/disaster/covid-19?publicLaw=all

broad flexibility to decide how best to use this funding to meet the needs of their communities[226]. As of December 2021, $350 billion had been allocated to states, counties, cities, tribal governments, territories, and non-entitlement units of local government[226].

Another recent influx in federal funds that can be used for mitigation actions is the Infrastructure Investment and Jobs Act that was passed by Congress on November 6, 2021. This once-in-a-generation investment in infrastructure includes legislation that addresses repairing and rebuilding roads and bridges with a focus on climate change, mitigation, and resilience, and making the nation’s infrastructure resilient against the impacts of climate change, cyber-attacks, and extreme weather events[226].The ways in which this legislation will be administered is still being determined at the time this plan was written.

SECTION 7: PLAN MAINTENANCE

Requirements:

- **§201.6(c)(4)(i):** [There is a] description of the method and schedule for keeping the plan current (monitoring, evaluating, and updating the mitigation plan within a 5-year cycle).
- **§201.6(c)(4)(iii):** [The plan discusses] how the community will continue public participation in the plan maintenance process.

2022 HMP Update

- The section has been reviewed and updated for planning dates and deliverables.
- Additional worksheets were added to facilitate the monitoring and evaluation process.
- The section has been reformatted for clarity and flow.

7.1 Overview

The mitigation plan is a living document that guides action over time. As conditions change, new information becomes available, or actions progress over the life of the plan, adjustments may be necessary to maintain its relevance and effectiveness.

Periodic revisions and updates of the *Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan (MJAHMP)* are required to ensure that the goals of the plan are kept current considering potential changes in hazard vulnerability and mitigation priorities. In addition, revisions may be necessary to ensure that the plan is in full compliance with applicable Federal and State regulations. Periodic evaluation of the Plan will also ensure that specific mitigation actions are being reviewed and carried out according to each participating jurisdiction's individual Mitigation Action Plan for Implementation.

Implementation and maintenance of the plan work in parallel to ensure successful execution of the mitigation strategy. **Section 6** includes a discussion of the process all municipalities will follow to implement the plan and integrate the requirements of the mitigation strategy into other planning mechanisms. **Section 7** provides the overall approach for plan maintenance and outlines the method and schedule for monitoring, evaluating, and updating the plan. Each jurisdictional annex provides a detailed description of how the MJAHMP will be integrated into existing planning mechanisms within the municipality. The implementation and maintenance processes will serve to periodically assess project status, identify benchmarks, make appropriate adjustments (if needed), and generally ensure that the planning process is ongoing and that progress in risk reduction is being made. The scope of this section includes the following plan maintenance steps:

- 7.2 Method and Schedule for Monitoring and Evaluating the Plan.
- 7.3 Method and Schedule for Updating the Plan.
- 7.4 Incorporation into Existing Planning Mechanisms.
- 7.5 Continued Public Involvement.

This section includes procedures to implement each phase of the plan maintenance process by assigning responsibility to a position or entity to complete each action; identifying the method and schedule for action implementation; and providing the sequenced format for collecting, analyzing, and reporting information that will keep the plan up to date.

Plan maintenance activities take place at two levels. This section describes how the Chittenden *MJAHMP* Planning Committee ("AHMPUC"), supported by the Chittenden County Regional Planning Commission (CCRPC) will carry out the plan maintenance functions related to the regional **Base Plan** and its supporting appendices and attachments. Likewise, each jurisdiction has the authority and responsibility to maintain its own separate **Jurisdiction Annex** to the plan and may establish an internal schedule consistent with the regional planning area's schedule. As an example, a jurisdiction may determine a semi-annual review of mitigation actions is appropriate to monitor progress, especially if a number of short-term actions are being implemented and completed simultaneously. Each municipality has designated a lead position to be responsible for and coordinate the plan maintenance process within their respective municipality.

Table 7.1: Municipal Lead for Plan Maintenance Activities

Municipality	Lead
Town of Bolton	Town Clerk & Treasurer
Enance related ;Buels Gore	Gore Supervisor
City of Burlington	City Engineer
Town of Charlotte	Planner
Essex Police Department Also represented the Town of Essex Junction	Chief of Police
Town of Hinesburg	Town Administrator
Town of Huntington	Resident appointed by Town
Town of Jericho	Town Administrator
Town of Milton	Director of Public Safety
Town of Richmond	Town Planner
Town of St. George	Town Clerk & Treasurer

Town Shelburne	Town Manager
City of South Burlington	Director of Planning & Zoning
Town of Underhill	Town Administrator
Town of Westford	Zoning Administrator
Town of Williston	Planning Director & Zoning Administrator
City of Winooski	Fire Chief

If a jurisdiction no longer wishes to actively participate in the development, implementation, and maintenance of the plan, they must notify the CCRPC staff and Vermont Emergency Management (VEM) in writing.

Plan Maintenance Concept and Responsibilities

The plan maintenance process provides regional and community officials with an opportunity to evaluate those actions that have been successful and to explore the possibility of documenting potential losses avoided due to the implementation of specific mitigation measures. Plan review also affords the opportunity to address mitigation actions that may not have been successfully implemented as assigned.

Beginning with the 2017 *MJAHMP*, the CCRPC enhanced its participation in and support of the AHMPUC. The CCRPC staff, in coordination with VEM, reconvened the AHMPUC and conducted annual questionnaires, and developed reporting for the plan as described in the sections titled **7.2 Method and Schedule for Monitoring and Evaluating the Plan** and **7.3 Method and Schedule for Updating the Plan**. The associated Annual Monitoring Reports documenting progress by the individual municipalities and the CCRPC for the 2017 *MJAHMP* are maintained by the CCRPC. Based on the successful monitoring and evaluation of progress in implementing the current plan, this process will be continued during the next planning cycle.

Plan Monitoring and Evaluation Roles and Responsibilities	
CCRPC Staff	• Coordinate and facilitate the monitoring process • Initiate and maintain schedule of monitoring activities • Collect data and disseminate reports • Maintain records and documentation of all monitoring activities

Mitigation Plan Review and Update Committee/Municipal Representatives	• Participate in the monitoring process as requested by the CCRPC staff • Assist in collecting and analyzing data • Assist in disseminating reports to stakeholders and the public • Maintain records and documentation of all jurisdictional monitoring activities • Promote the mitigation planning process with the public and solicit public input

7.2 Method and Schedule for Monitoring and Evaluating the Plan

Plan Review Schedule

The *MJAHMP* will be reviewed on the schedule described in this plan.

- **Annually** to monitor the effectiveness of the plan and identify required or recommended changes or amendments.
- **Biennially** to evaluate changes in hazard risk or vulnerability, or in implementation of the mitigation strategy, including resources and outcomes.
- **Within three months after the declaration of a federal disaster** for plan review, revisions and/or project prioritization.
- **When required or needed** due to changes in federal or state legislation and/or regulations that impact hazard mitigation in Vermont.

Plan Review Method

1. Annual Questionnaire to municipalities

Commencing in January 2023 and each January thereafter during the lifecycle of this plan, CCRPC staff will send a questionnaire/worksheet to officials from each of the county's municipalities inquiring about the status of the identified mitigation actions outlined in the municipality's annex. The questionnaire will address:

- What progress was made on each mitigation action in the prior calendar year.
- CCRPC staff will complete implementation status reports for regional mitigation strategies listed in the *MJAHMP* (**Attachment A**) and send the implementation status reporting worksheet for municipal mitigation actions (**Attachment B**) to each municipality. CCRPC staff will compile the results of completed questionnaires and status reports.

2. Biennial Review

In conjunction with plan monitoring, CCRPC staff will, in the fall of 2023 and 2025, conduct a more thorough review of the *MJAHMP* and all jurisdictional annexes to assess whether:

- The goals and objectives address current and expected conditions.
- The nature, magnitude, and/or type of risks have changed.
- The current resources are appropriate to implement the plan.
- There are implementation problems (e.g., technical, political, legal, fiscal, or coordination issues).
- The outcomes have occurred as expected.
- The departments, agencies and other partners participated as originally proposed.

The *Biennial Evaluation Worksheet* (**Attachment C**) will be used to perform this review.

3. Post-Federal Disaster Declaration

Following a federal disaster declaration that includes Chittenden County, the CCRPC staff will convene the AHMPUC to review mitigation actions that could be eligible for potential funding and review lessons learned to determine if revisions are needed to any section of the plan, or to address specific circumstances arising from the event.

4. Summary Monitoring and Evaluation Report

The CCRPC staff will prepare two draft Summary Monitoring and Evaluation Reports, one in mid-2024 and the other in mid-2026. The intent of the evaluation processes outlined above is to regularly focus attention on the plan and its implementation between the five-year updates.

A copy of the draft reports will be posted on the CCRPC's website, along with public notice of availability to review reports and invite public comments.

A copy of the draft reports will also be provided to VEM, the statewide Local Emergency Management Planning Committee, the Regional Emergency Management Committee, and participating municipalities for review and input. After a two-week comment period, public comments will be summarized and attached to the report. The CCRPC will then prepare a Final Summary Monitoring and Evaluation Report for review and approval by a majority vote of the AHMPUC.

A copy of the final approved Report will be sent to the LEPC, the REMC, the Vermont State Hazard Mitigation Officer (SHMO), and the participating municipalities. Depending on the evaluation results, the CCRPC or a municipality may initiate the Plan update process prior to the scheduled five-year update in late 2027.

The CCRPC will convene the AHMPUC for meetings to review the results of the annual questionnaires and the biennial reports on this tentative schedule:

- In May of each year starting in 2023 following final approval of the *MJAHMP*
- July of the third year (2025) following final approval of the *MJAHMP*
- Beginning in 2026, the Committee will establish a schedule for more frequent meetings as the Plan Update process accelerates for developing the 2027 HMP update.

Revisions to the Base Plan and Supporting Annexes

Any necessary substantive revisions to the *Chittenden MJAHMP* elements prior to the next update cycle shall be the responsibility of the CCRPC and the participating municipalities in this MJAHMP following the plan amendment process outlined in state and FEMA guidance. It must be stressed that progress on any required revisions can only be achieved if the CCRPC is provided sufficient financial resources for the needed staff time.

Plan Amendment Process

Changes to the regional *MJAHMP*, other than administrative changes, will necessitate the review and approval of the AHMPUC; review and approval by VEM and FEMA; and re-adoption of the amended plan by the municipal governing bodies.

The AHMPUC and its participating municipalities will forward information on proposed change(s) to all interested parties including, but not limited to, affected county and municipal departments, residents, and businesses. When a proposed amendment may directly affect specific private individuals or properties, each jurisdiction will:

- Follow existing local, state or federal notification requirements which may include published public notices as well as direct mailings.
- Disseminate the information in order to seek public input on the proposed amendment(s) for not less than a 30-day review and comment period.
- At the end of the 30-day review and comment period, forward the proposed amendment(s) and comments to the AHMPUC for final consideration.

The AHMPUC will review the proposed amendment along with the comments received from other parties, and if comments are deemed to be acceptable, will submit a recommendation for the approval and adoption of changes to the Plan to each appropriate governing body within 60 days. In determining whether to recommend approval or denial of a plan amendment request, the following factors will be considered by the AHMPUC:

- There are significant errors, inaccuracies, or omissions made in the identification of issues or needs in the Plan.

- New issues or needs have been identified that are not adequately addressed in the current Plan.
- There has been a significant change in information, data, or assumptions from those on which the Plan is based.
- There has been a significant change in local capabilities to implement proposed hazard mitigation activities.

Upon receiving the recommendation from the AHMPUC and prior to adoption of the Plan, each municipal governing body will hold a public hearing. The governing body will review the recommendation from the AHMPUC (including any relevant factors listed above) and any oral or written comments received at the public hearing. Following that review, the governing body will make one of the following recommendations for action to the AHMPUC:

- Adopt the proposed amendments as presented.
- Adopt the proposed amendments with modifications. (Recommended modifications must be presented with the proposed amendment(s).)
- Refer the amendment request back to the AHMPUC for further consideration and/or additional hearings.

Revisions to Jurisdiction Annexes

Local participating municipalities have the authority to approve/adopt changes to their own Action Plans for Implementation without approval from the CCRPC or the AHMPUC; however, the AHMPUC and CCRPC should be advised of all changes as a courtesy and for consideration as changes or modifications to the regional *MJAHMP*. The CCRPC will be responsible for verifying that the proposed change will not affect the jurisdiction's compliance with current State and Federal mitigation planning requirements.

Municipalities may make administrative changes or updates to their mitigation actions and Action Plans for Implementation in their jurisdiction annexes at any time in coordination with the CCRPC staff.

The relative strength and effectiveness of this method and schedule for monitoring and evaluating the plan is contingent upon funding from Emergency Management Planning grants, Hazard Mitigation Assistance grants, or similar sources. Adherence to the monitoring, evaluation and update process schedule will ensure that the Plan is kept current throughout its five-year cycle.

7.3 Method and Schedule for Updating the Plan

This plan maintenance step reviews and revises the Plan on an established schedule to reflect changes in hazard risk, priorities, development, and progress in local mitigation efforts. FEMA regulations require that the hazard mitigation plan be updated, adopted, and approved every five years for the municipalities to maintain eligibility for pre-disaster mitigation funding. This five-year update cycle helps ensure that the plan remains current and relevant.

The plan review and revision process is ongoing throughout the five-year life cycle of the plan. Monitoring and evaluation activities that are conducted annually, biennially, and following a major disaster, will assist in maintaining currency of multiple components of the plan, such as the hazard identification and risk assessment, and mitigation actions and priorities.

The end date for completion of updating the plan will be five years from the date the approved plan is adopted by the first jurisdiction. It is anticipated that the first adoption will occur in (Month/Day/2022), which would set a tentative date for plan expiration in (Month/Day/2027).

Table 7.1: *Chittenden MJAHMP* Update Roles and Responsibilities

Plan Update Roles and Responsibilities	
CCRPC Staff*	• Coordinate and facilitate the plan review, revision, and update process • Maintain schedule of all plan update activities • Collect data and disseminate reports • Maintain records and documentation of all monitoring, evaluation, and update activities • Identify and implement opportunities for public participation and input in the update process, including review of the revised draft plan
Mitigation Plan Review and Update Committee/Municipal Representatives	• Represent the jurisdiction and participate in the planning cycle, including the plan review, revision, and update process • Collect and report data to the Update Coordinator • Maintain records and documentation of all jurisdictional plan review and revision activities • Promote the mitigation planning process with stakeholders and the public and solicit public input

**The responsibility for updating the plan may be assigned to the CCRPC, Contracted firm, or other designated entity.*

The plan update process and schedule are designed to focus on various components of the plan throughout the five-year cycle. Based on the schedule described, all parts of the plan will have been reviewed by the end of the fourth year of the five-year planning cycle, potentially reducing the time and resource burden in the final planning year. Upon completion of the review and update process, the *MJAHMP* will be submitted to VEM for final review and approval in coordination with FEMA.

Plan Update Procedure

The update process outlined for the 2022 plan maintains the CCRPC as the “lead” planning entity to facilitate the update process. Although an outside entity was contracted with the primary responsibilities to prepare the 2022 Plan update, it is assumed that in the future the CCRPC will continue its long-term role in supporting hazard mitigation planning in some capacity with Chittenden County municipalities, whether as a primary or sub-contractor. Consequently, the plan update procedure identifies the CCRPC as the facilitator for the next plan update; however, this role could be in coordination with another entity that would be determined at the time of the update process.

The following plan update procedure will be carried out:

1. CCRPC will seek a pre-disaster mitigation grant or other grants to fund the plan update.

2. CCRPC will start convening its All Hazards Plan Update Committee (AHMPUC) within at least 12 months of the Plan’s expiration date. As is now the case, membership will include representatives appointed by each municipality’s governing body, and one or more commissioners representing CCRPC. In addition, ex-officio officials from Vermont DEM and the Vermont Agency of Natural Resources (ANR) will be invited to participate on the committee.

3. The AHMPUC will review the Summary Monitoring and Evaluation Reports; the Plan’s identified hazards; the hazard risk methodology; and the multi-jurisdictional mitigation strategies to determine whether they are still appropriate, or whether modifications or additions are needed based on current knowledge and conditions.

4. Comments and recommendations made in the FEMA Plan Review Tool for the previous plan update will be reviewed and considered for the next Plan Update.

5. Based on AHMPUC input, CCRPC staff will update relevant data in the Plan and prepare a draft Plan update. CCRPC will then convene a meeting of the AHMPUC for the specific purpose of reviewing the draft Plan update. The goal of this meeting is to reach consensus on changes to the draft Plan update and the format of the municipal annexes. In the event no consensus is reached, a vote by a simple majority of the AHMPUC voting members present will decide to accept the draft Plan.

6. CCRPC will incorporate the changes as recommended by the AHMPUC and then work with municipal staff and officials to update their individual annexes to accurately reflect the municipality’s current hazard mitigation concerns, capabilities, and recommended municipal goals and actions.

7. CCRPC will schedule a public presentation to each municipal governing body in order to formally present the draft update of the *MJAHMP* and the relevant municipal annex. Each governing body may provide, if it so chooses recommendations for further changes to the updated Multi-Jurisdictional Plan and to its individual annex.

8. The public may observe the presentations and provide comments, if desired, on the *MJAHMP* and individual municipal annexes. The draft updated plans will be posted on the CCRPC website for public review and comment for a minimum of 30 days.

9. CCRPC staff will incorporate the public and municipal comments into the *MJAHMP* and the individual municipal annexes.

10. CCRPC may submit the *MJAHMP* and municipal annexes to FEMA Region I for approval pending adoption.

11. CCRPC staff will finalize the changes to the *MJAHMP* and the annexes and distribute these to CCRPC and municipal governing bodies to consider a resolution of re-adoption. Upon adoption by CCRPC and all participating municipalities (within three months of the time that the CCRPC has completed presentations to all municipal governing bodies), the updated plan will be submitted by the CCRPC (or contracting entity) to FEMA Region I along with copies of the annexes adopted to date. Copies of all adopting resolutions will also be submitted to FEMA as they are executed.

Each municipality may review and update its own programs, initiatives, and projects at any time in order to reflect changing conditions, priorities, and opportunities during the five-year cycle of the individual jurisdiction annex.

A municipality may choose not to re-adopt the updated *MJAHMP* and its respective jurisdictional annex, acknowledging that the failure to re-adopt a multi-jurisdictional or local jurisdiction plan will result in the jurisdiction no longer being eligible for FEMA hazard mitigation grant programs. A municipality may choose to develop, adopt, and submit its own Local Hazard Mitigation Plan to VEM for approval, consistent with the requirements of the Disaster Mitigation Act of 2000 and regulations contained in 44 CFR 201 & 206 in order to maintain eligibility.

7.4 Incorporation into Existing Planning Mechanisms

An ongoing responsibility of CCRPC, AHMPUC members, and jurisdictional representatives is to identify additional stakeholders and existing planning mechanisms that can be integrated into mitigation planning as part of short- and long-term community development and resiliency planning. This involves establishing hazard mitigation as a community planning priority that can be supported through the same community capabilities defined in **Section 5**:

- Planning and Regulatory

- Administrative and Technical
- Safe Growth
- Fiscal and Resources
- Education and Outreach

Each step in the planning cycle includes ongoing opportunities to identify existing planning processes that will provide a platform for integration of hazard mitigation planning.

The mitigation strategies contained in this Plan can be incorporated into CCRPC's future planning mechanisms in two primary ways:

- Chittenden County Regional Planning Commission (CCRPC) – One of the strongest and most successful planning partnerships that has taken place to implement recent *MJAHMP's* is that carried out by the CCRPC. The *MJAHMP* has been utilized and incorporated as a component of the *Chittenden County Regional Environment, Community, and Sustainability "ECOS" Plan*[227], most recently adopted on June 20, 2018[228]. In addition, regional strategies identified in the *ECOS Plan* are linked to the goals and objectives defined in the *MJAHMP* and have been updated for 2022. Also, the mitigation actions identified in the *MJAHMP* are linked to actions identified in the *ECOS Plan*. (See **Section 6, Mitigation Strategy**.) The CCRPC's process for updating the *ECOS Plan* will consider and incorporate as appropriate the data, analyses, and mitigation strategies of the *MJAHMP*. In addition, the annual questionnaire completed by municipalities as a component of the *MJAHMP* monitoring process links local mitigation actions to regional actions, noting the implementation status and progress made in reducing risk.

- CCRPC Annual Work Program – The CCRPC will consider and incorporate mitigation strategies and actions into its annual Work Program contingent on having sufficient available resources.

Opportunities exist for municipalities and other entities to incorporate this Plan's mitigation strategies into their own planning mechanisms. These include, but are but not limited to:

- Municipal comprehensive plans
- Municipal capital budgets
- Municipal zoning bylaws and subdivision regulations
- Open space preservation programs

[227] Chittenden County Regional Environment, Community, and Sustainability (ECOS) Plan dated June 20, 2018. Retrieved at: https://www.ccrpcvt.org/our-work/our-plans/ecos-regional-plan/

[228] The approved 2017 Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan, dated March 6, 2017, is posted on the Chittenden County Regional Planning Commission website, at: https://www.ccrpcvt.org/our-work/emergency-management/hazard-mitigation-plan/

Some of the mitigation strategies in this *MJAHMP* and the municipal annexes identify specific actions to incorporate mitigation strategies into other planning mechanisms. Other opportunities may become apparent as strategies are implemented. The ability of municipalities and other entities to incorporate this Plan's mitigation strategies into other planning mechanisms is contingent on adequate funding and staffing resources.

Specific local planning initiatives that provide the opportunity to integrate hazard mitigation are described in the **Action Plan for Implementation** in each jurisdiction annex.

7.5 Continued Public Involvement

A critical part of plan maintenance is continuing to identify and provide opportunities for stakeholder and public engagement in the planning process and plan implementation. Significant Plan changes or amendments may require a public hearing prior to implementing adoption procedures.

Ongoing efforts to involve the public in the maintenance, evaluation, and revision process will include the following activities.

- The adopted and approved *MJAHMP* and jurisdiction annexes will be posted on the CCRPC's website on an on-going basis, along with a link to submit comments and suggestions for improvement.

- Public involvement activities related to the 2022 update to the Chittenden County *ECOS Plan*, includes a section on public safety that draws from the *MJAHMP*. The *ECOS Plan* update process will include public meetings and opportunities for public comment in relation to the *MJAHMP*.

- Any proposed changes to the text of the *MJAHMP* (not including the jurisdiction annexes) shall follow the plan updating process described in the previous section, which includes the opportunity for public review and comment of draft plans.

References to opportunities for stakeholder and public involvement are addressed in plan maintenance steps.

Implementation of the Plan

The systems and procedures described in this section support the implementation of this plan through the following measures:

- Annual review method and schedule that monitors and evaluates all elements of the plan and tracks the implementation of the plan over time.

- Incorporating the plan into existing planning mechanisms that support long-term resiliency planning.
- Documenting progress in risk reduction through prioritizing and implementing local mitigation actions.

To assist with the plan maintenance process, **Attachments A, B and C** are provided as worksheet templates. The following tables (or ones similar to them) will aid responsible entities in identifying Mitigation Actions that support Regional Mitigation Strategies for Chittenden County, and facilitate annual **monitoring** of the plan.

Attachment A: CCRPC Regional Mitigation Strategies –Action Implementation Monitoring Worksheet

Category A:	
Action (Primary Responsible Entity and Partners)	**Report on Progress since Plan Adoption (Mitigation Actions)**
Action #:	[Description of action} Progress: ______________________________
Action #:	[Description of action} Progress: ______________________________
Action #:	[Description of action} Progress: ______________________________
Action #:	[Description of action} Progress: ______________________________
Action #:	[Description of action} Progress: ______________________________

Attachment B: Municipal Mitigation Actions - Implementation Monitoring Worksheet

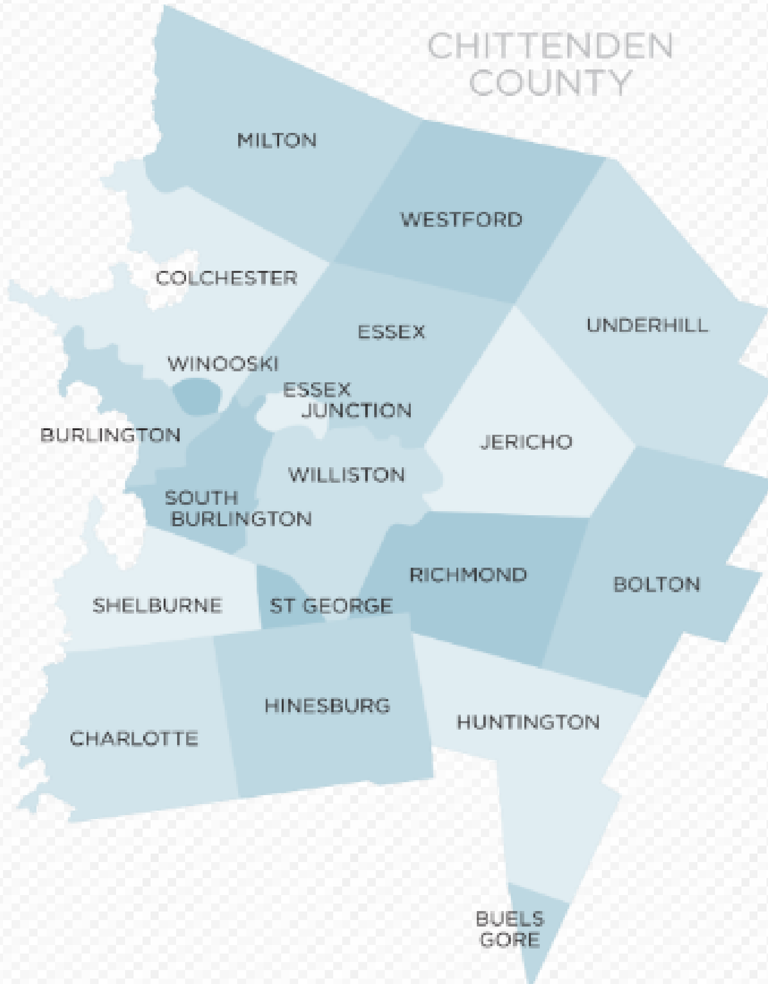
Instructions: Copy/paste additional table for each Action update.

Municipality:		
Progress Report Period:	**From Date:**	**To Date:**
Action/Project Title:		
Responsible Department or Agency:		
Contact Name:		
Contact Phone/Email:		
Project Status:	□ Action completed □ Action deleted □ Action in progress Anticipated completion date ___________________________ □Project delayed Explanation: ____	
Comments: (Provide details related to the project's status, including obstacles and challenges to projects not yet started or deleted; and data related to completed projects including risk reduction achieved, and total cost.)		

Attachment C: Chittenden County Multi-Jurisdictional All-Hazards Mitigation Plan – Biennial Evaluation Worksheet

The following table will aid responsible entities in implementing the mitigation strategy for Chittenden County and facilitate annual **evaluation** of the plan. The table will be completed by the CCRPC staff or entity assigned with the responsibility to annually evaluate the plan.

Evaluation Component	Yes	No
2022 REGIONAL GOALS		
Goal 1: Protect existing and planned municipal infrastructure. **Goal 2**: Protect life and residential and business properties from natural and manmade hazards. **Goal 3**: Promote and enhance opportunities for public education about hazard mitigation. **Goal 4**: Encourage municipalities to formally incorporate their local All-Hazards mitigation plan into their comprehensive plan, as well as incorporate proposed mitigation actions into various bylaws, regulations, and ordinances, and municipal operating and capital improvement plans. **Goal 5**: Promote appropriate planning for growth with a focus on change climate and resiliency.		
Are the goals still comprehensive and relevant?		
Policies, Regulations, and Studies		
Are there any new or updated laws, policies, regulations, initiatives, and studies that contribute to the hazard risk assessment or identified mitigation actions been approved and/or adopted within the past year and should be addressed in the Plan?		
By adding this information to the plan, would it initiate the amendment process?		
Funding Programs and Planning Mechanisms		
Have there been any changes in local, commonwealth, and/or federal agencies and their funding procedures, new grant programs or areas of focus, and potential integration into existing planning mechanisms?		
By adding this information to the plan, would it initiate the amendment process?		
Hazard Risks and Vulnerabilities		
Is there new or updated data and information that can contribute to risk assessments, loss estimates, or asset vulnerabilities for participating municipalities?		
By adding this information to the plan, would it initiate the amendment process?		
Mitigation Actions		
Has progress been made in previously implemented actions that reduce vulnerability and losses?		
Are there any new opportunities for mitigation actions?		
By adding this information to the plan, would it initiate the amendment process?		
Integration of Mitigation into Existing Planning Mechanisms		
Are there new opportunities to integrate hazard mitigation planning or implementation of actions into other planning mechanisms?		
By adding this information to the plan, would it initiate the amendment process?		
Comments:		



» **Cover Photo Credits:**

» **Chittenden County Regional Planning Commission**