Town of Glastenbury
Hazard Mitigation Plan

Adopted
December 7, 2018

Glastenbury, Vermont

Town of Glastenbury

Glastenbury, Vermont

Letter of Adoption

The Town of Glastenbury has worked with the Bennington County Regional Commission to identify hazards, identify past and potential future losses due to natural disasters and identify strategies for mitigating future losses. The Town appointed a planning team that identified mitigation actions listed in the hazard mitigation plan. The Town will implement the recommended actions assuming funding is available.

As the Town Supervisor of the Town of Glastenbury, I adopt the Town of Glastenbury Hazard Mitigation Plan.

Rickey Harrington

12/7/18
Date

Rickey Harrington
Supervisor of the Town of Glastenbury
1185 Glastenbury Road
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I. Introduction

A. Purpose

Hazard mitigation actions are designed to reduce potential losses from natural hazards such as flooding, landslides, wildland fire, and similar events. Hazard mitigation plans identify, assess and prioritize those hazards and present actions that a community can undertake to reduce risks and damage from those natural hazards (Federal Emergency Management Agency 2013a).

This plan is intended to identify, describe and prioritize potential natural hazards that could affect the Town of Glastenbury in Bennington County, Vermont and provide specific measures to reduce or avoid those effects. The Federal Emergency Management Agency (FEMA), within the U.S. Department of Homeland Security and Vermont Emergency Management both advocate the implementation of hazard mitigation measures to save lives and property and reduce the financial and human costs of disasters.

The format of this plan is as follows. Section II provides a profile of the town, including a discussion of the environmental setting, demographics and settlement patterns. Section III describes the planning process along with lists of members of the planning team and dates of meetings and public and agency review. Section IV analyzes the following hazards:

- Flooding and Fluvial Erosion
- Winter Storms
- High Wind Events
- Hail
- Temperature Extremes
- Drought
- Wildfire
- Landslides
- Earthquake
- Hazardous Materials Spill
- Infectious Disease Outbreak
- Invasive Species

Section V assesses vulnerability, and Section VI discusses mitigation goals and actions, including current programs and town capabilities. Section VII describes how the plan will be maintained and updated.

B. Mitigation Goals

The town identified the following mitigation goals:

1. Reduce injury and loss of life resulting from natural disasters.
2. Reduce damage to public infrastructure, minimize disruption to the road network and maintain both normal and emergency access.
3. Establish and manage a program to proactively implement mitigation projects for roads, bridges, culverts and other municipal facilities to ensure that community infrastructure is not significantly damaged by natural hazard events.
4. Design and implement mitigation measures so as to minimize impacts to rivers, water bodies and other natural features, historic structures, and neighborhood character.
5. Increase the economic resiliency of Glastenbury by reducing the economic impacts incurred by municipal, residential, agricultural and commercial establishments due to disasters.
6. Incorporate hazard mitigation planning into other community planning projects, such as the Town Plan and Capital Improvement Plan.
7. Ensure that members of the general public continue to be part of the hazard mitigation planning process.

Most municipalities in Vermont have Local Emergency Operations Plans (LEOP) that would be listed in goal 6 above. However, Glastenbury is an unorganized town and therefore is exempt from having to submit a LEOP.

II. Town Profile

A. Regional Context

The Town of Glastenbury is one of five unorganized towns in the State of Vermont. Pursuant to V.S.A. Title 24 Chapter 43, the Governor appoints one Supervisor for the unorganized towns in each county. Acting within his or her general duties, the Town Supervisor appointed the Bennington County Regional Commission (BCRC) to act as Glastenbury's Planning Commission. The Town Supervisor appoints the Zoning Board of Adjustment and the Zoning Administrator. The unorganized Town of Glastenbury is located in the central part of Bennington County, Vermont and is surrounded by the towns of Arlington, Sunderland, Stratton, Somerset, Searsburg, Woodford, Bennington and Shaftsbury (Map 1).

Glastenbury is accessible by only one town road, appropriately called Glastenbury Road, which begins in the neighboring Town of Shaftsbury (Map 2). Glastenbury Road serves three year-round residences and two seasonal dwellings in Glastenbury, as well as two year-round residences in Shaftsbury. The Vermont Agency of Transportation maintains this road, grading it several times a year and plowing snow when necessary. The only other road in Glastenbury is

U.S. Route 7, a limited access federal highway. Route 7 traverses through the northwest corner of town for a total of 1.8 miles. Glastenbury is primarily forested (Map 2).

Glastenbury comprises the most mountainous terrain in Bennington County. Twelve of the town's mountain peaks rise to elevations over 3000 feet. The ridgeline of Glastenbury Mountain, reaching a peak elevation of 3,748 feet, forms the division between the Hudson River watershed and the Connecticut River watershed. Drainage through many narrow valleys occurs in all directions. The Fayville Branch, a tributary of the Batten Kill, drains the Fayville area in the northwestern corner of town. The South Fork of the Roaring Branch, another tributary of the Batten Kill, drains the north of Glastenbury. An extensive drainage system in the east of town, including the Glastenbury River, Blind Brook, Deer Lick Brook, Deer Cabin Brook and Castle Brook, forms the headwaters of the Deerfield River, a major tributary of the Connecticut River. The southern and western parts of Glastenbury are drained by Bolles Brook, Bickford Hollow Brook, Furnace Brook and Basin Brook. All these brooks are tributaries of the Walloomsac River, which flows westward to the Hudson.

The steep mountainous terrain and poor soils, combined with a very short growing season, made productive farming virtually impossible. When the population dwindled to seven after the timber had been exhausted, the Vermont Legislature in 1937 declared Glastenbury an unorganized town.

B. Demography and Land Use

The total land area of Glastenbury is 27,341 acres. Nearly 94 percent of this land, or 25,618 acres, is within the Green Mountain National Forest. The Glastenbury Wilderness Area was established in 2006 (see Map 1). Of the remaining 1,723 acres, located predominantly around Fayville, over 1,170 acres are currently managed for timber production. There are miles of gravel logging roads, requiring several bridges and many culverts. The Vermont Agency of Transportation owns about 89 acres, which constitutes the U.S. Route 7 right-of-way.

The population as of 2017 is 6. The only settled area is near the abandoned Village of Fayville in the northwest part of town along the Shaftsbury town line. This area also includes the transportation corridor of US 7.

In recent years, large tracts of the former Glastenbury Timberlands Inc. land holdings were sold to the United States Forest Service to be incorporated into the Green Mountain National Forest. There are three permanent households, one large seasonal home, and five camps.

C. Economic and Cultural Resources

Table 1. Numbers of properties by classification. Source: 2014 Grand List	
Residential	3
Seasonal Home	6
Utilities	1
Woodland	1
Total	10

Economic resources are best summarized by the types of uses. The grand list describes the assessed values of different classes of properties and can be used to identify the number of tax parcels by use type (Table 1). Map 3 shows the two land use designations from the 2015 Glastenbury Town Plan. Forest District One is located along the western border and includes Glastenbury Road and all houses within the town. Forest District Two represents the majority of the town and consists of remote and mountainous terrain, mostly owned by the U.S. Forest Service.

The concentration of development provides for large areas, primarily in higher elevations and steeper slopes, to remain forested. At the same time, the costs of maintenance of major roads, water and sewer and other services are reduced.

D. Critical Facilities

Table 2 lists and describes critical facilities. Glastenbury doesn't have town facilities, utility substations, schools, or sites with hazardous substances. The only critical facilities in the town are transportation routes. These are shown on Map 4.

Table 2. Glastenbury Critical Facilities		
Label	Name	Description
1	Route 7 Underpass	Transportation Route
2	Vermont Route 7	Transportation Route
3	Bridges and Culverts	Transportation Route

Glastenbury also contains both a Surface Water Source Protection Area and a Groundwater Source Protection Area for public water supplies in Shaftsbury (Map 4).

III. Planning Process

A. Planning Team

The Bennington County Regional Commission began discussions with the town on developing a hazard mitigation plan in 2015. The Glastenbury Planning Commission and Town Supervisor decided to initiate planning in 2016. This is the first hazard mitigation plan for Glastenbury. The hazard mitigation planning team consisted of members listed in Table 3.

Table 3. Planning committee members	
Name	Affiliation
Rickey Harrington	Town Supervisor
Jerry Mattison	Glastenbury EMD
Cinda Morse	Glastenbury Planning Commission
Michael Gardiner	Glastenbury Planning Commission
Rob Fayley	Road Foreman
Jim Henderson	Zoning Administrator
David Kiernan	Shaftsbury Town Manager

B. Public Involvement

Glastenbury started the planning process in 2015 and held several planning committee meetings. These meetings were warned according to the Vermont Open Meeting Law and dates are listed in Table 4. There were residents present at each of the meetings but there were no comments.

Table 4. Dates of planning meetings and public and agency review	
Meeting	Date(s)
Town Supervisor Board initiates planning process	Fall of 2015
Planning committee organization meeting	September 22, 2015
Planning committee meeting	October 20, 2015
Planning committee meeting	January 21, 2016
Planning committee meeting	May 1, 2017
Planning committee meeting	June 5, 2017
Planning committee meeting	August 2, 2017
1st Draft made available for public and agency review by the planning committee	March 19,2018
Planning committee meeting and vote to send to FEMA	April 17, 2018
Adoption of FEMA approved plan	December 7, 2018

Discussions at the planning meetings focused on past events that may have affected Glastenbury, descriptions on the background and capabilities of the town, the vulnerability and risk assessment and identifying mitigation actions.

Glastenbury does not have a town hall or town website. Therefore the plan was made available to the public at the Bennington County Clerk's Office, the Shaftsbury Town Hall and posted on the website of the Bennington County Regional Commission. The plan was sent to the select board chairs or town officials of the surrounding towns of Shaftsbury, Bennington, Woodford, Searsburg, Somerset, Stratton, Sunderland and Arlington, and to the Chair of the Local Emergency Planning Committee 7.

Each were asked to share the plan with appropriate staff and officials. Comments were requested by email, phone or letter and were to be sent to Jim Henderson of the Bennington County Regional Commission. No comments were received.

C. Hazard Assessment

The following sections provide a detailed assessment of each of the hazards identified by the planning team based on data from the following sources listed in Section VIII References:

a. Local knowledge.
b. The National Climate Data Center (NCDC) storm events database (most recent data from their FTP site).
c. FEMA lists and descriptions of past disaster declarations.
d. The Vermont Department of Forests, Parks and Recreation data on wildfires.
e. HAZUS runs on potential earthquake damage.
f. Cooperative weather observer data and station normals where available.
g. Palmer Hydrologic Drought Index calculated from 1985 to 2015 from the National Oceanographic and Atmospheric Administration (NOAA).
h. Hazardous materials spills from the Vermont Agency of Natural Resources (VT ANR).
i. Infectious disease outbreaks listed from the Vermont Department of Health.
j. Observations of invasive species compared to the state and federal lists of noxious species.
k. The Vermont Hazard Mitigation Plan (2013).
l. New England Weather, New England Climate (Zielinski and Keim 2003), Vermont Weather Book (Ludlum 1996).
m. Federal Emergency Management Agency 2010 Flood Insurance Study, Bennington County, Vermont and Incorporated areas, Federal Emergency Management Agency Study Number 5003CV000A.
n. National Weather Service 2016. Advanced Hydrologic Prediction Service, stream gauge information for the Hoosic River near Williamstown, MA. Available via: http://water.weather.gov/ahps2/hydrograph.php?wfo=aly&gage=wilm3.
o. Spatial Hazard Events and Losses Database (SHELDUS) records which were not as complete as NCDC and, therefore, not used.
p. Fuel types and potential for wildfire from LANDFIRE (http://www.landfire.gov/) and the Vermont Department of Forests, Parks and Recreation.
q. Vermont Agency of Natural Resources and Vermont Agency of Agriculture, Food and Markets on invasive species.
r. Identification of ranking of the potential for landslides by Josh Duncan (2015), a student at Green Mountain College using a modified protocol based on Clift and Springston (2012).

With respect to NCDC data, there have been numerous changes to that database in just the last few years. While NCDC data goes back to 1950, there was a dramatic change in 1996 in the way data were collected. The number of events recorded in years prior to 1996 is far fewer than from 1996 onward. Therefore, for the best reliable data, we used only data from 1996 onwards. We have also looked at the other sources of historical weather data. The cooperative weather observers for Peru, Sunderland and Pownal in Vermont have the most consistent long-

term data, though some data was available from the North Adams, MA observer. The only stream gauge for Bennington County is in Bennington near the New York border on the Walloomsac. The Walloomsac is in a different watershed than the Batten Kill, which encompasses Glastenbury. There are no weather stations that record or keep long-term data records in Glastenbury except for the cooperative weather stations listed above that record daily observations, but not the specifics of storm events.

We have communicated with USGS, which is working on models of areas impacted by different storm events using Lidar and stream gauge data, but they are not working in Vermont yet, as far as we know. We looked at the USGS high water marks for Irene (Medalie and Olson 2013), but they were located only along the Batten Kill in Arlington and portions of the Roaring Branch and Walloomsac in Bennington with none recorded in Glastenbury. Therefore, we relied mostly on the updated special flood hazard maps for potential flooding extent.

Finally, we reviewed several studies on potential impacts of climate change developed by the Intergovernmental Panel on Climate Change (Christensen et al 2013), the Vermont Agency of Natural Resources (Tetra Tech 2013), the University of Vermont (Galford et al 2014), the Global Climate Change Research Program (Horton et al 2014), and the U.S. Forest Service (Rustad 2012). The relationship between climate change and the frequency and extent of natural hazards is a developing science, and we described, where appropriate, how climate change might affect hazards in the future.

IV. Hazard Assessment

A. Flooding and Fluvial Erosion

1. Description

a. Flooding

Flooding and associated fluvial erosion are the most frequent and damaging natural hazards in Vermont. The National Weather Service (2010) defines a flood as “any high flow, overflow, or inundations by water which causes or threatens damage.” A flash flood is …”a rapid and extreme flow of high water into a normally dry area, or a rapid water rise in a stream or creek above a predetermined flood level.” These are usually within six hours of some event, such as a thunderstorm, but may also occur during floods when rainfall intensity increases, thereby causing rapid rise in flow. The NWS uses the following impact categories:

- Minor Flooding - minimal or no property damage, but possibly some public threat.
- Moderate Flooding - some inundation of structures and roads near stream. Some evacuations of people and/or transfer of property to higher elevations.

- Major Flooding - extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.
- Record Flooding - flooding which equals or exceeds the highest stage or discharge observed at a given site during the period of record keeping.

Floods may reach these magnitude levels in one or more reaches, but not necessarily all. Runoff from snowmelt in the spring, summer thunderstorms, and tropical storms and hurricanes can all result in flooding in Glastenbury. Ice jam flooding can occur on Vermont rivers when substantial ice forms followed by several days of warmth, snowmelt and any rainfall leading to ice breakup. As the ice breaks up on the rivers, chunks of ice form jams which cause localized flooding on main stem and tributary rivers. Ice jams are most prevalent during the January thaw (late January) and in March and April as spring approaches.

Flash floods can occur after spring melt of mountain snow, following large storms such as Tropical Storm Irene, or after significant thunderstorms. Bennington County towns received finalized FEMA Digital Flood Hazard Maps (DFIRMs) that became effective December 2, 2015. However, there are no Special Flood Hazard Areas mapped in Glastenbury due to its high elevation. Map 5 shows the location of surface waters and river corridors (formerly fluvial erosion hazard zones). See section A. 3. for more information.

Headwaters of Glastenbury can be very flashy and more often flood losses would be caused by fluvial erosion. Fluvial erosion can range from gradual bank erosion to catastrophic changes in the location of the river channel (Vermont River Management Program 2010).

There is one dam located in Glastenbury. It is owned by the forest service and is shown on Map 5.

b. Fluvial Erosion

In Vermont, most rivers flow through relatively confined valleys, but still meander over time across the floodplain. River corridors provide an area within which a river can move across the landscape as it dissipates energy and transports and deposits sediments. Where rivers are constricted by bridges and other structures or rip rap, the water moves at higher velocity, resulting in downcutting and collapse of the banks. This may undermine structures within the corridor.

2. Previous Occurrences

Ludlum (1996) describes numerous storm events that have affected Vermont since settlement, but the local impacts of these are difficult to trace. The 1927 flood was the largest recorded disaster in the history of the state. The state received over six inches of rain, with some areas receiving 8-9 inches. Following a rainy October, this storm occurred from November 2nd through the 4th causing extensive flooding. Two storms occurred in March of 1936. Heavy

rains and snowmelt caused significant flooding. Two years later, the 1938 hurricane caused both flooding and extensive wind damage.

Table 5 shows a total of 49 flood events in Bennington County from 1996 to 2015, using NCDC data. These have been primarily minor and affected either specific streams, such as the Batten Kill and the Walloomsac, or specific towns.

Hurricanes and tropical storms that form in tropical waters have historically affected New England, but are relatively infrequent. Besides the 1938 storm, Tropical Storm Belle brought significant rains to Vermont in 1976 and Hurricane Gloria brought rain and wind damage in 1985. Glastenbury has been subjected to two major tropical storms in the past twenty years. Hurricane Floyd was a Category 4 storm before hitting North Carolina, and then was reduced to a tropical storm when it reached southern New England. Tropical Storm Irene was the remnant of Hurricane Irene, which was a Category 1 hurricane. A category 1 storm has winds of 74-95 miles per hour and could damage roofs, down shallow-rooted trees and damage power lines (http://www.nhc.noaa.gov/aboutsshws.php).

Table 1. Total number of flood events by type and year for Bennington County.
Source: National Climate Data Center 2017

Year	Flash Flood	Flood	Total
1996	3	6	9
1997			
1998	1	3	4
1999	2		2
2000	4	1	5
2001			
2002	1		1
2003		2	2
2004	1	5	6
2005		5	5
2006		1	1
2007	1	1	2
2008			
2009	2		2
2010			
2011	3	3	6
2012			
2013	4		4
2014			
2015			
2016			
2017		1	1
Total	22	28	50

The following describes nineteen moderate and extreme events that have occurred since 1996, using the National Weather Service (2010) categories, which affected Glastenbury or nearby areas. These events were described in the National Climate Database records (2017). It should be noted that only the January 1996 event occurred in the winter, with all other events in the spring, summer or fall. Ice jam flooding does occur and one instance of damage is described below.

January 19 to 20, 1996 (DR-1101 1/19 to 2/2 1996): An intense area of low pressure which was located over the Mid-Atlantic region on Friday morning January 19 produced unseasonably warm temperatures, high dewpoints and strong winds. This resulted in rapid melting of 1 to 3 feet of snow. In addition to the rapid snowmelt, 1 to 3 inches of rain fell as the system moved northeast along the coast. This resulted in numerous road washouts and the flooding of several homes across the county. *Note that this was also categorized as a High Wind event.

April 24, 1996: Significant rains on Tuesday evening April 23 resulted in flooding along the Walloomsac and Batten Kill Rivers. The Walloomsac River crested 1.5 feet over flood stage at North Bennington and the Batten Kill

crested 1 foot over flood stage at Arlington. The flooding resulted in several road closures but much of the flooding was minor.
December 2, 1996: Rainfall during the late fall season resulted in flooding across parts of Bennington County. The Walloomsac River flooded in North Bennington. Several homes were flooded along with Route 67A. The Batten Kill at Arlington flooded with several homes affected.

January 24, 1999: The combination of rain and very mild temperatures produced rapid snowmelt in southern Vermont. This runoff and ice jams triggered flooding on the upper Batten Kill near Arlington and on the Walloomsac River near Bennington.

September 16 to 17, 1999 (DR-13079/16-21 1999): The remnants of Hurricane Floyd brought high winds and heavy rainfall (3-6 inches) to southern Vermont. Many smaller tributaries reached or exceeded bankfull. Estimated wind gusts exceeded 60 mph, especially over hill towns. Power outages occurred across southern Vermont. A Cooperative Weather Observer recorded 4.94 inches of rain in Sunderland and 4.60 inches in Pownal.

July 14-17, 2000 (DR- 1336 7/14-18 2000): Thunderstorms caused torrential rainfall with flash flooding washing out sections of roadways in northeast Bennington County and southern Bennington County. Route 7 was closed due to flooding and rockslides and 67 was closed due to flooding. Numerous other roads were closed, with some washed out. This rain produced enough runoff to cause the Batten Kill to exceed the six-foot flood stage by about 1 foot at Arlington, 47 year high. The swelled river flooded the Batten Kill Canoe Company and adjacent river property. A Cooperative Weather Observer recorded 3.39 inches of rain in Sunderland.

May 28, 2002: Scattered thunderstorms developed along a quasi-stationary front on the afternoon of May 28. These storms were slow moving and contained torrential rainfall across southern Vermont. Rainfall amounts reached around three inches in a couple of hours in Bennington County.

March 29, 2003: An area of low pressure, moving along a slow moving cold front on March 29 and 30, produced up to 2 inches of rainfall across extreme southern Vermont. The rain, combined with seasonably mild temperatures, melted much of the remaining snow pack across this area and produced a significant runoff. Both the Walloomsac and Batten Kill Rivers briefly went above flood stages in sections. The Walloomsac gage at Bennington crested at 8.19 feet, compared to the flood stage of 7.5 feet. The Batten Kill gage at Arlington crested at 6.3 feet, 0.3 feet above its flood stage.

July 21 to August 18, 2003 (DR-1488 7/21-8/18 2003): Severe storms and flooding affected Vermont including Bennington County. (Note: this event does not appear in the NCDC data.) A Cooperative Weather Observer recorded sporadic and sometimes large amounts of precipitation during this period in Sunderland.

March 31 through April 2, 2004: As much as 3 inches of rain fell between March 31 through April 2 across southern Vermont. This rain combined with the last of the snowmelt produced an

excessive runoff of water. As a result, flooding took place in Bennington County. Schools were closed due to flooding. The gage on the Batten Kill River in Arlington, rose to 6.9 feet, nearly a foot above the 6-foot flood stage during the predawn hours of April 3.

May 25, 2004: The Walloomsac River exceeded its flood stage of 7.0 feet, cresting at 7.75 feet at the gage in Bennington.

September 18, 2004: The Walloomsac River exceeded its flood stage of 7.0 feet, cresting at 7.21 feet at the Bennington gage.

October 9, 2005: North Bennington Road at Bennington closed due to flooding.

November 30, 2005: On November 30, the Walloomsac River had minor flooding at Bennington. The river crested at 8.51 feet.

January 18-19, 2006: High wind and 1 to 2 inches of rain fell across eastern New York and western New England. Flooding occurred on the Walloomsac River at Bennington on January 18 and January 19. Flood stage is 7.0 feet; the river crested at 8.00 feet.

April 16-17, 2007 (DR-1698 4/15-21 2007): An intense coastal storm spread heavy precipitation across southern Vermont, starting as a mixture of snow, sleet and rain which changed to all rain. Liquid equivalent precipitation totals ranged from 3 to 6 inches leading to minor flooding across portions of southern Vermont. A Cooperative Weather Observer recorded 3.54 inches of rain in Sunderland.

August 28-29, 2011 (DR-4022 8/27-29 2011): Tropical Storm Irene produced widespread flooding, and damaging winds across the region. Rainfall amounts averaged 4 to 8 inches and fell within a twelve-hour period. A Cooperative Weather Observer recorded 5.16 inches of rain in Sunderland and the Bennington Morse State Airport reported 4.23 inches of rain from August 27 to 28. In Bennington County, widespread flash flooding and associated damage was reported countywide, with many roads closed due to flooding and downed trees and power lines. Strong winds also occurred across southern Vermont, with frequent wind gusts of 35 to 55 mph, along with locally stronger wind gusts exceeding 60 mph. The combination of strong winds, and extremely saturated soil led to widespread long duration power outages.

During Irene, two undersized culverts on Glastenbury were plugged by debris causing flooding and severe erosion of the road, shoulder and ditches. The abutment on bridge #2 was severely eroded and collapsed. Cell phone service was lost in Glastenbury, resulting in poor communications.

September 5-7, 2011: Large amounts of moisture from the remnants of Tropical Storm Lee interacted with a frontal system producing heavy rainfall with total rainfall amounts ranging from 3 to 7 inches led to widespread minor to moderate flooding across southern Vermont. A Cooperative Weather Observer in Sunderland recorded 4.63 inches of rain between September

5 and 9. Pownal recorded 6.70 inches of rain between September 5 and 9, and the Bennington Morse State Airport recorded 3.49 inches from September 4 to 8. Minor flooding occurred on the Walloomsac River at Bennington.

May 21-29, 2013: Over several days, thunderstorms brought heavy rains and some flash flooding.

June 2, 2013: Thunderstorms brought heavy rain to the area, primarily the town of Bennington.

July 2, 2017: Thunderstorms brought heavy rain, primarily affecting the town of Bennington.

3. Extent and Location

The primary damages from past events have been from flooding and fluvial erosion with secondary damage from wind. There have been no NFIP-designated repetitive losses within Glastenbury. Map 5 shows the mapped flood zones and river corridors. There is no other available data on the extent of flooding or fluvial erosion. Map 5 also shows damages identified during Tropical Storm Irene. Fayville Branch and Bolles Brook are steep streams that carry extensive amounts of water and debris downhill in large storms or after spring melts. These could potentially damage the Route 7 bridge and the Bennington municipal water intake and treatment facility.

In addition to the above events, the Peru, Pownal and Sunderland Cooperative Observer recorded precipitation. Table 6 shows those months by year where that value exceeded the 90th percentile, which varies by site and month. Several events of that magnitude have occurred where flooding was not recorded in NCDC records or local knowledge, but this does provide additional information on potential flooding extent.

Table 6. Months where rainfall exceeded the 90th percentile (precipitation totals, in inches, in parentheses) of monthly precipitation at the Peru, Pownal and Sunderland Cooperative Observer Stations from 1980 to 2013 for Pownal, 1980 to 2017 for Peru and 1990 to 2013 for Sunderland.

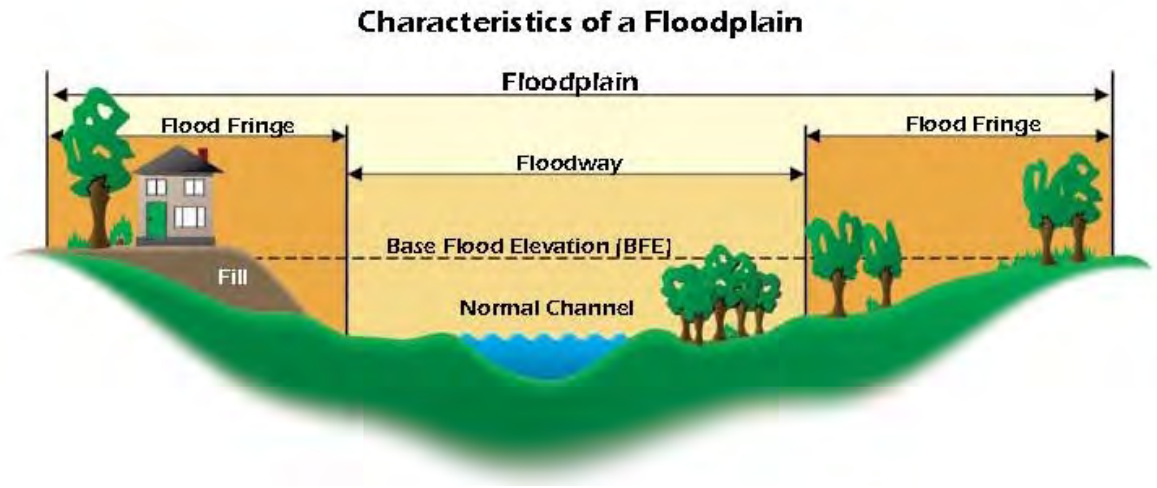
Sunderland		Pownal	Peru
Month	Year	Year	Year
January	1990, 1998, 1999 (5.97”)	1996, 1998, 1999, 2006 (3.88”)	1990, 1999, 2006, 2012 (5.04”)
February	2002, 2008, 2011 (3.58”)	1981, 1984, 2008 (3.54”)	1981, 2002, 2008, 2016 (5.28”)
March	2001, 2007, 2008 (5.35”)	1980, 1999, 2001, 2007 (4.65”)	1980, 1986, 2001, 2008 (6.13”)
April	1993, 1996, 2002, 2007, 2011 (4.75”)	1983, 1990, 1993, 1996 (4.80”)	1983, 1996, 2007, 2017 (6.43”)
May	1990, 2000, 2006 (6.31”)	1984, 1990, 2013 (6.47”)	1984, 1990, 2012, 2017 (8.29”)
June	1998, 2002, 2006 (7.66”)	1998, 2000, 2002, 2013 (7.32”)	1998, 2006, 2013, 2015 (9.26”)

Table 6. Months where rainfall exceeded the 90th percentile (precipitation totals, in inches, in parentheses) of monthly precipitation at the Peru, Pownal and Sunderland Cooperative Observer Stations from 1980 to 2013 for Pownal, 1980 to 2017 for Peru and 1990 to 2013 for Sunderland.			
Sunderland		Pownal	Peru
July	1996, 2004, 2008 (6.87")	1984, 2004, 2010 (6.20")	1988. 1996, 2000, 2013 (7.31)"
August	1990, 2003, 2011 (7.37")	1990, 1991, 2003, 2011 (7.37")	1985. 1990, 2003, 2011 (8.32")
September	1999, 2003, 2011 (5.75")	1999, 2004, 2011 (6.03")	1987, 1999, 2003, 2011 (6.92")
October	2005, 2007, 2010 (7.05")	1987, 1995, 2010 (5.81")	1987, 1995, 2010 (9.02")
November	2002, 2004, 2005 (5.28")	1985, 1988, 2005 (5.81")	1983, 1986, 1988, 2002 (6.36")
December	1996, 2003, 2008 (6.42")	1983, 1990, 2003, 2011 (4.77")	1983, 1996, 2008, 2014 (6.74")

The average annual precipitation in Vermont has increased 5.9 inches since 1960. This trend is predicted to continue so that Vermont streams will have higher flows and possibly experience more frequent and greater flooding events (Galford et al 2014).

Special Flood Hazard Areas: these are areas mapped by FEMA and using the LIDAR derived zones that were adopted in late 2015. Figure 1 below shows the parts of a typical floodplain. Due to its high elevation, there are no special flood hazard areas in Glastenbury, and, therefore, Glastenbury is not a participating member of the National Flood Insurance Program.

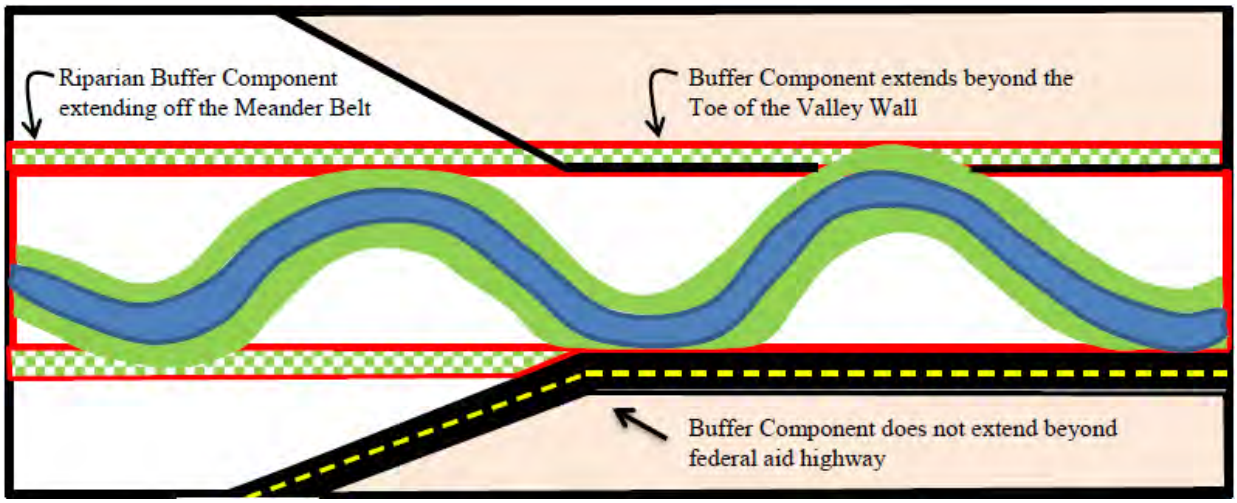
Figure 1. Typical floodplain



River Corridors: River corridors (Figure 2) have been mapped by the Vermont Agency of Natural Resources using geospatial data and will be modified by VT ANR river scientists using available field data. The data were used to calculate the "meander belt width" or area within which a river would move across the valley. As rivers shift their location both vertically and horizontally, erosion of adjacent lands can occur and threaten properties that may be outside of special

flood hazard areas (Vermont River Management Program 2010). While there are mapped river corridors in Glastenbury, none affect developed areas within the town (Map 5).

Figure 2. River corridors



4. Probability, Impact, and Vulnerability

Based on data from 1996 to 2015, eighteen moderate or major flood events have affected areas within or near Glastenbury resulting in a 95% chance of such an event occurring in any given year. Even though flooding events occur almost every year, the potential proportion damaged within the town from severe flooding would range from 1-10% with injuries of 1-10%, because there are no special flood hazard areas in Glastenbury and zero buildings located in the river corridors. In addition, most services recover in less than seven days, though help for specific property owners may take significantly longer.

Probability and impact percentages were determined by an assessment of current available data.

B. Winter Storms

1. Description

Winter storms are frequent in Vermont. Winter storms may consist of heavy snow, mixed precipitation, or ice storms and all may be accompanied by strong winds. Potential damages can include power outages, traffic accidents, and isolation of some areas. For example, the October 4, 1987 storm stranded travelers in the area and knocked out power for several days. This storm was particularly troublesome as trees still had leaves on them, so power outages were extensive. The "Blizzard of ’93," one of the worst storms on record,

virtually shut down Vermont on the weekend of March 13-14, forcing the closure of roads and airports. Snowfall amounts ranged from 10 to 28 inches across the state.

In rare cases, the weight of snow may collapse roofs and cause other structural damage. Wind accompanying snowstorms can increase the effect of the snow damage. In addition to snow, ice storms occur when the lower levels of the atmosphere and/or ground are at or below freezing, and rain is falling through warmer air aloft. The precipitation freezes upon contact with the ground, objects on the ground, trees and power lines.

2. Previous Occurrences

Table 7 summarizes the 143 winter storm events that have occurred in Bennington County since 1996. As can be seen, a high number of events occurred in 1997, 2007, 2008, 2009 and 2011. Using NCDC data, we categorized the extent of each storm with storms ranked as "High" if they produced more than twelve inches of snow or were categorized by the NCDC as producing heavy or record snows or blizzards or significant icing. The Blizzard of 1993 was categorized as "Extreme." The NCDC also reports numerous storms producing one to over three feet of snow in the Green Mountains, but these were not listed, as they did not affect major population centers. The following is a summary of significant events.

Table 7. Total number of winter storm events by type and year for Bennington County.
Source: National Climate Data Center 2017.

Year	Blizzard	Heavy Snow	Ice Storm	Winter Storm	Winter Weather	Totals
1996		5		2		7
1997		1		7	2	10
1998				2	1	3
1999				4		4
2000		1		6		7
2001				6		6
2002				5		5
2003				5		5
2004				2		2
2005	1	3		2		6
2006						0
2007		3	1	6	4	14
2008		4	1	1	11	17
2009		3		1	10	14
2010		3		1	2	6
2011				5	5	10
2012				4	2	6
2013		2		1	4	7
2014		2		4		6
2015		2			7	9
2016		1			5	6
2017	1	3		1	7	12

Table 7. Total number of winter storm events by type and year for Bennington County. Source: National Climate Data Center 2017.						
Year	Blizzard	Heavy Snow	Ice Storm	Winter Storm	Winter Weather	Totals
Totals	2	33	2	65	60	162

January 2 to 3, 1996 Heavy Snow: A major winter storm developed over the Gulf coast states on January 2 and tracked northeast along the eastern seaboard during January 3. Heavy snow fell across southern Vermont with the average snowfall ranging from 10 to 12 inches.

November 26, 1996 Winter Storm: Over Bennington and Windham Counties, snow and heavy freezing rain downed trees and power lines and caused numerous accidents. Across southern Vermont, approximately 10,000 customers lost power.

December 7 to 8, 1996 Winter Storm: Heavy wet snow fell across southern Vermont resulting in 20,000 customers losing power. Dorset recorded 11 inches of snow, Peru recorded 14 inches, 12 inches were recorded in Shaftsbury and 11 inches in Pownal. Downed trees caused road closures and some were without power for several days.

March 31 to April 1, 1997 Winter Storm: A nor'easter formed bringing rain that changed to snow with totals of 12 inches in Shaftsbury and 13 inches in Peru. The wet snow caused power outages and road closures.

December 29 to 30, 1997 Winter Storm: Wet snow and strong winds combined to down trees and power lines. Route 7 was closed for several hours.

January 14 to 15, 1999 Winter Storm: Heavy snow fell across eastern New York and southern New England with 11 inches reported in Dorset. The storm was accompanied by extremely cold conditions with reported temperatures of -9 Fahrenheit.

December 30 to 31, 2000 Winter Storm: A general swath of 6 to 12 inches of snow fell across the region with locally higher amounts across the hills. Specific amounts included 13 inches in Pownal, and 8 inches in Bennington.

February 5 to 6, 2001 Winter Storm: A swath of heavy snowfall accumulating 12 inches or more fell across southern Vermont. In Bennington County, specific accumulations included 12 inches in Bennington and 14 inches in Pownal.

March 5 to 6, 2001 Winter Storm: An extended period of moderate to heavy snow resulted in 26 inches in Pownal and 27 inches in Peru. This was one of the largest snowfalls in southern Vermont since the Blizzard of 93.

November 17, 2002 Winter Storm: A mixture of snow, sleet and freezing rain, along with strong winds and trees still with leaves, resulted in downed trees and powerlines from Arlington to the New York State Line.

December 6 to 8, 2003 Winter Storm: The first major snowstorm of the winter resulted in 20.5 inches of snow reported in Pownal.

January 15 to 16, 2007 Ice Storm: Freezing rain and sleet resulted in widespread downed trees and power lines with accompanying widespread power outages. Significant icing, with ice accretions of 1/2 inch up to 1 inch, occurred from the freezing rain.

February 14, 2007 Heavy Snow: Snowfall in excess of 2 feet across portions of Bennington County resulted in closed schools and businesses. Strong winds created near blizzard conditions during parts of the event.

April 15 to 16, 2007 Winter Storm: Heavy, wet snow, ranging from 8 to 12 inches, downed trees and power lines causing widespread outages.

December 16 to 17, 2007 Winter Storm: Snow, heavy at times, mixed with sleet Sunday afternoon and evening. Total snow and sleet accumulations ranged from 10 to 14 inches, with 14 inches reported at Woodford. The combination of strong winds, and the extra weight of heavy wet snow on tree limbs also downed trees and power lines in portions of Bennington County during Sunday. The heavy snow and sleet resulted in numerous school and business closings Monday morning, and also created treacherous travel conditions for the morning commute.

February 12 to 13, 2008 Winter Storm: Snow accumulated to 4 to 7 inches and was accompanied by freezing rain with 1/4 to 1/3 of an inch of ice.

December 11 to 12, 2008 Ice Storm: Rainfall in rates of 1/4 to 1/3 of an inch per hour fell creating ice accumulations of 1/2 to 3/4 of an inch. Snow and sleet mixed in some areas. An estimated 15,000 customers lost power and businesses and schools were shut for several days. Very cold temperatures followed the storm. Numerous warming shelters were setup to assist those who were without power and heat.

January 1 to 3, 2010 Heavy Snow: A strong storm brought 10 inches to over 2 feet of snow across Bennington and Windham counties.

February 23 to 24, 2010 Heavy Snow: Heavy snow totaling 1 to 2 feet fell across southern Vermont with highest amounts at elevations above 1500 feet.
February 26 to 27, 2010 Heavy Snow: Just after the storm described above, a second storm brought 1 to 2 feet in higher elevations with lesser amounts below 1000 feet in elevation.

December 26 to 27, 2010 Winter Storm: Heavy snow falling at rates of 1 to 3 inches per hour resulted in one to two feet of snow. Winds were strong and gusted to 35-45 mph.

January 12, 2011 Winter Storm: A strong storm resulted in 14 inches to 3 feet of snow falling at rates of 3 to 6 inches per hour.

February 1 to 2, 2011 Winter Storm: Snowfall was generally 10 to 18 inches but ranged to 25 inches in some areas.

February 25, 2011 Winter Storm: Snow fell at rates of 1 to 2 inches per hour with totals of 12 to 17 inches across southern Vermont.

October 29 to 30, 2011 Winter Storm: While not yet winter and with trees with much of their foliage still on, 5 to 14 inches fell across Bennington County. Trees and power lines came down due to the weight of the wet snow.

February 13 to 14, 2014 Winter Storm: Snow fell at rates of up to 3 inches per hour. Over the two days of the storm, 8 to 21 inches fell in southern Vermont. At times, winds gusted to 40 mph as the storm left the area.

November 26 to 27, 2014 Winter Storm: An early storm affected southern Vermont over the Thanksgiving period with 8 to 15 inches of total snow accumulation.

February 2, 2015 Heavy Snow: Most areas received 9 to 15 inches, although some areas within the high terrain of the southern Green Mountain saw up to 19 inches.

February 6 to 10, 2015 Heavy Snow: Snow amounts between 1 and 2 feet, with the highest amounts across the high terrain of the southern Green Mountains.

February 9, 2017 Heavy Snow: Snow totaled 8 to 14 inches with higher amounts at higher elevations.

March 14 to16, 2017 Blizzard: A major storm with rats of 1-4 inches/hour and strong winds resulted in 18 inches of snow at low elevations and greater amounts at higher elevations. Many roads and schools were affected.

December 12 to 13, 2017 Heavy Snow: Light to moderate snow became heavier with 7 to 12 inches in general and 16 inches at higher elevations.

3. Extent and Location

The average annual snowfall in Bennington County is 64.4 inches, with December, January, February and March as the primary months for snowfall. Extreme snowfall events for one, two and three day events have ranged from 12 to over 20 inches. The skill of road crews in

Vermont means that only the heaviest snowstorms (>12 inches) or ice storms affect the populations.

Increasing temperatures that are predicted to occur will likely reduce total winter snowfall. If precipitation falls as rain in the winter, river flows will be higher due to the lower evapotranspiration in the winter. Freezing rain may become more frequent, with resulting impacts to the transportation and power systems (Galford et al 2014).

4. Probability, Impact and Vulnerability

There is a 100% probability of a moderate or greater snowstorm affecting Bennington County, including Glastenbury in any given year. These are large-scale events, though local impacts may vary greatly. Roads and power lines are most vulnerable, with traffic accidents the most likely to create injuries. Route 7 is steep so conditions can become treacherous. Power outages could be short term (a few hours) or last seven or more days. Some roads may remain impassable for long periods as well.

C. High Wind Events

1. Description

High wind events can occur during tropical storms and hurricanes, winter storms and frontal passages. Thunderstorms can produce damaging winds, hail and heavy rainfall, the latter potentially producing flash floods. The NCDC recorded 69 thunderstorms with damaging winds in Bennington County since 1996. Events categorized as “strong wind” tended to occur during the winter months.

Tornadoes are formed in the same conditions as severe thunderstorms. Intense, but generally localized damage can result from the intense winds. The primary period for tornado activity in New England is mid-summer (Zielinski and Keim 2003). Tornadoes will generally follow valleys in the northeast and dissipate in steep terrain. The NCDC recorded three tornadoes in Bennington County since 1990.

2. Previous Occurrences

Table 8 below summarizes the total number of significant wind events including thunderstorms, strong winds, and tornadoes from 1996 to 2015. The 1998 tornado registered F2 on the Fujita damage scale. The 2002 tornado in Bennington County registered F1 while the 2003 tornado was an F0 to F1 (National Climate Data Center 2015). The Fujita scale is based on windspeed and typical damage. An F0 tornado has winds of less than 73 miles per hour and could damage chimneys, branches and down shallow rooted trees. An F1 tornado has winds of 73-112 miles per hour and could damage roofs, push mobile homes off foundations and blow

cars off of roads. An F2 tornado has winds of 113-157 miles per hour and could tear off roofs, destroy mobile homes and snap trees (http://www.spc.noaa.gov/faq/tornado/f-scale.html).

Wind speed data is not available for wind events due to the lack of weather stations. NCDC data (2015) rarely included estimates of wind speed. Generally, wind speeds of greater than 55 miles per hour are considered damaging (National Oceanographic and Atmospheric Administration 2006). Events that occurred in or near Glastenbury are described below.

Table 8. Summary of wind events in Bennington County.
Source: National Climate Data Center 2017

Year	High Wind	Strong Wind	Thunderstorm Wind	Tornado	Funnel Cloud	Totals
1996	5					5
1997	2	2	6			10
1998	1		8	1		10
1999	2		4			6
2000	1		1			2
2001			3			3
2002	1		3	1		5
2003	1			1		2
2004						0
2005	1		3			4
2006	6		4			10
2007	3		6			9
2008		3	5			8
2009	2		1			3
2010	5		3		1	9
2011	1		8			9
2012	2		3			5
2013			6			6
2014			3			3
2015			2			2
2016		1	7			8
2017	4	3	5			12
Totals	37	9	81	3	1	131

July 17 and July 18, 1997 Thunderstorm Wind: Severe thunderstorms downed trees across Bennington County.

February 24 to 25, 1996 High Wind: Damaging winds downed many trees across southern Vermont and produced scattered power outages.

March 19 to 20, 1996 High Wind: Damaging winds downed three utility poles north of Bennington on Route 7. In Shaftsbury, trees fell on two homes and there were numerous reports of trees and wires down.

May 31, 1998 Thunderstorm Wind and Tornado: Strong thunderstorms generated an F2 tornado in New York, which became an F1 after crossing into Vermont. The tornado followed Route 67 through North Bennington and South Shaftsbury.

September 7, 1998 Thunderstorm Wind: A derecho downed trees in Woodford.

September 16 to 18, 1999 (DR-13079/16-21 1999): Remnants of Hurricane Floyd (see flooding and flash flooding) brought winds gusting to over 60 mph and downed trees and power lines in southern Vermont.

November 2, 1999 High Wind: Localized high wind gusts occurred in the Green Mountains during the evening hours. A wind gust of 66 mph was recorded at the Bennington Automated Surface Observing System (ASOS) site, located at the Bennington Morse State Airport.

December 12, 2000 High Wind: Strong winds downed trees and powerlines across Bennington County.

August 9, 2001 Thunderstorm Wind: Scattered severe weather caused trees to be blown down in Bennington as well as in Arlington.

June 5, 2002 Thunderstorm Wind and Tornado: Thunderstorms originating in New York produced an F1 tornado that touched down in Woodford Hollow. Tornado winds were estimated between 125 and 150 mph. Non-tornadic thunderstorm winds blew some trees down in the Town of Pownal. Lightning struck a home in North Bennington causing a very small fire with minimal damage to the structure of the house.

July 21, 2003 Tornado: A supercell originating in New York produced a significant tornado there. The supercell spawned a second tornado that touched down in Pownal, then moved northeast into Bennington, downing trees and causing minor damage. The tornado continued into the Green Mountain Forest in western Windham County, where it caused significant forest damage.

October 29, 2006 High Wind: Strong winds, some reaching 60 mph, blew from the evening of October 28 through part of October 29.

December 1, 2006 High Wind: A measured wind gust of 58 mph was recorded by the Bennington ASOS. Trees were reported down in Shaftsbury due to thunderstorm winds.

March 2, 2007 High Wind: High winds were recorded, along with snow and freezing rain. Winds at Bennington Morse State Airport reached 59 mph.

July 15, 2007 Thunderstorm Wind: Wires were reported down in Shaftsbury due to strong thunderstorm winds.

December 16, 2007 High Wind: A snowstorm brought 8 to 14 inches of snow along with strong winds that combined to down trees and powerlines across Bennington County.

July 20, 2008 Thunderstorm Wind: A storm brought down trees and wires and blocked Route 7A northeast of Manchester.

December 9, 2009 High Wind: Power outages were reported due to high winds across Bennington County affecting the towns of Bennington, Pownal, Shaftsbury, Sunderland, Sandgate, Manchester and Dorset. A measured wind gust of 59 mph was recorded at the Bennington Morse State Airport.

May 8, 2010 Thunderstorm Wind: Thunderstorms generated winds in excess of 40 mph downing trees in Arlington and Manchester.

July 17, 2010 Funnel Cloud: A funnel cloud was reported on Route 279 in Bennington.

August 22, 2010 High Wind: Strong winds formed during passage of a cold front. Downed trees and wires were reported in Arlington, Bennington, Shaftsbury and Sunderland.

September 30 to October 1, 2010 High Wind: A low pressure system and remnants of Tropical Storm Nicole off shore created winds gusting to over 55 mph with power outages reported.

June 9, 2011 Thunderstorm Wind: A pre-frontal trough formed a line of severe thunderstorms that moved across eastern New York and southern Vermont.

August 28-29, 2011 (DR-4022 8/27-29 2011): Along with flooding described above, Tropical Storm Irene brought 35-55 mph winds with gusts exceeding 60 mph resulting in downed trees and powerlines throughout Bennington County.

October 29 to 30, 2012 High Wind: Superstorm Sandy brought strong winds of 40-60 mph, with a gust of 41 mph recorded at the Bennington Morse State Airport. The highest wind gust in southern Vermont occurred in Woodford, where a wind gust of 58 mph was reported.

May 21, 2013 Thunderstorm Wind: A broken line of thunderstorms created downed wires and trees in Dorset.

June 2, 2013 Thunderstorm Wind: Showers and thunderstorms developed across the region aided by very strong winds. A few storms became severe, producing large hail and wind damage. The thunderstorms also produced very heavy rainfall, which caused flash flooding in Bennington. Multiple trees were reported down and one tree fell on two parked trucks as a result of the thunderstorm winds.

July 19, 2013 Thunderstorm Wind: Thunderstorm winds downed trees in Manchester and Sunderland.

July 3, 2014 Thunderstorm Wind: Thunderstorms affected Bennington County.

June 23, 2015 Thunderstorm Wind: Thunderstorms resulted in downed trees in the town of Bennington.

July 1, 2015 Thunderstorm Wind: Again, thunderstorms affected the town of Bennington.

July 1, 2016 Thunderstorm Wind: Damaging thunderstorms brought down trees and wires in Manchester.

July 23, 2016 Thunderstorm Wind: Damaging thunderstorms brought down trees and wires in Sunderland.

August 13, 2016 Thunderstorm Wind: Arlington and Manchester received damaging during thunderstorms.

October 22 to 23, 2016 Strong Wind: Some isolated trees were downed and power outages occurred during a long wind event that had periodic gusts to 50 mph.

January 10 to 11, 2017 High Wind: Winds gusting from 40 to 60 mph occurred during a long-term wind event.

March 1 to 2, 2017 High Wind: Some power outages occurred as a result of winds with gusts of 30 to 45 mph.

May 5, 2017 High Wind: A strong, but short duration wind with gusts to 68 mph downed trees and resulted in power outages throughout Bennington County.

July 1, 2017 Thunderstorm Wind: Strong thunderstorms resulted in a microburst in Sandgate with estimated winds exceeding 100 mph.

August 22, 2017 Thunderstorm Wind: Strong to severe thunderstorms with a tornado watch resulted in some trees down in Southern Vermont.

3. Extent and Location

Damaging winds, including the previous occurrences described above, are those exceeding 55 miles per hour (National Oceanographic and Atmospheric Administration 2006 and undated). During a December 2009 event, winds were measured at 59 mph at the Morse Airport in Bennington. Higher winds were likely created during the three tornadoes. High wind events can strike anywhere. Where storms are funneled up the valleys, damage can be significant, but most likely less than 10% of structures would be affected. Again, power outages

could last up to seven or more days. There are no weather stations nor any records of wind data in Glastenbury.

4. Probability, Impact and Vulnerability

Wind events causing moderate or greater damage occur almost every other year (40-50%) in Bennington County, and can range from localized events from thunderstorms to wide ranging events from larger storms. The primary vulnerability would be power outages from downed trees and lines and the potential expected probability would be 10-100% in Glastenbury.

D. Hail

1. Descriptions

Hail is frozen precipitation that forms in severe thunderstorms. Hailstones can range in size from ¼" (about the size of a pea) to over four inches (grapefruit sized), though most hail is in the smaller categories of less than 1.5 inches. The strong up and downdrafts within thunderstorms push to freeze and down to collect water and this repeated cycle results in accumulation of ice until gravity pulls the hailstone to Earth.

2. Previous Occurrences

The National Climate Data Center has 30 reports of hail storms in Bennington County between 1996 and 2017, all associated with thunderstorms. The following were within Glastenbury or nearby towns.

May 31, 1998 Thunderstorm Winds and Tornado and Hail: Strong thunderstorms generated an F2 tornado in New York, which became an F1 after crossing into Vermont. The tornado followed Route 67 through North Bennington and south Shaftsbury. Hail was reported in Shaftsbury.

July 18, 2000 Hail: Hail was reported in Bennington and Sunderland

July 4, 2001 Hail: Half-dollar size hail fell in Sunderland.

June 19, 2006 Hail: Penny-sized hail was reported in Sunderland.

May 10, 2007 Hail: Quarter-sized hail was reported in Arlington.

June 21, 2007 Hail: Nickel-sized hail was reported in Sunderland.

August 3, 2007 Hail: Ping-pong ball size hail was reported in Shaftsbury.

August 6, 2008 Hail: Quarter-sized hail was reported in Arlington.

July 7, 2009 Hail: Penny-sized hail was reported in Bennington during a thunderstorm.

July 17, 2010 Hail: Quarter-sized hail was reported during a thunderstorm in Bennington.

July 21, 2010 Hail: Quarter-sized hail was reported during a thunderstorm in Bennington.

June 1, 2011 Hail: Hail the size of a half-dollar was reported in Arlington and golf ball size hail reported in Shaftsbury. Reports of hail were widespread.

June 2, 2013 Hail: Quarter-sized hail was reported during a thunderstorm in Bennington.

June 24, 2013 Hail: Quarter-sized hail was reported in Manchester.

July 1, 2016 Hail: Quarter-sized hail was reported in Manchester.

August 2, 2017 Hail: Severe thunderstorms occurred across southern Vermont with golf ball-sized hail reported.

Hail was also reported by a Cooperative Weather Observers on March 18, 2990 in Pownal, on May 25, 1999, May 8, 2000, July 18, 2000, July 5, 2001, August 4, 2001, June 2, 2002, August 1, 2008 and August 15, 2009 in Sunderland and on June 10, 2008 and May 8, 2010 in Peru.

3. Extent and Location

Hail can cover wide areas and has the potential for damaging crops, automobiles or glass within structures, as well as causing injury. Generally, however, hail storms affect relatively small areas as they form in thunderstorms, which are localized. Storms with the largest hail stones near Glastenbury were the half-dollar size hail in Sunderland in 2001, ping-pong size hail in Shaftsbury in 2007, and the half-dollar size hail in Arlington and golf ball size hail in Shaftsbury in 2011.

4. Probability, Impact and Vulnerability

Hail storms are generally local, affecting subareas within the town, though a group of thunderstorms can cause hail in multiple locations over a wide area. From past occurrences, about one thunderstorm per year generates hail that was recorded. So, the possibility of hail occurring in Glastenbury could range from 10-100%. The potential vulnerability would be localized to damage to structures or automobiles, though there could also be damage to vegetation. In general, these impacts would be localized.

E. Temperature Extremes

1. Descriptions

Temperature extremes entail periods of either excessive heat or extreme cold. Excessive heat is generally defined as periods when the normal high temperature is exceeded by ten degrees. So, in the summer, this would equal approximately 88-89 degrees in Glastenbury (Table 9). Excessive heat is recorded at other times, but does not have the health consequences of summer periods. In addition, the heat index, which factors in the high relative humidity levels of summer, is also a factor.

Extreme cold is not well defined. For those involved in outdoor activities, extreme cold, accompanied by wind, is when exposed skin would be subject to frostbite. However, for periods of power outages that might accompany winter storms, extreme cold could be thought of as when temperatures fall below freezing as that would not only affect personal health and the health of household animals, but could result in pipes freezing, and the loss of water supplies and perishables.

Table 9. Sunderland normal temperatures and precipitation for 1981 to 2010.
Source: National Climate Data Center: http://www.ncdc.noaa.gov/land-based-station-data/climate-normals/1981-2010-normals-data

Month	High Temperature (^{0}F)	Low Temperature (^{0}F)	Mean Temperature (^{0}F)	Precipitation (in)
January	28.5	9.5	19.0	3.44
February	33.7	11.2	22.5	2.82
March	40.9	19.5	30.2	3.55
April	54.3	31.0	42.7	3.47
May	65.8	41.3	53.5	4.33
June	75.3	49.6	62.5	4.66
July	78.5	54.5	66.5	4.55
August	77.1	53.0	65.0	4.40
September	69.6	44.2	56.9	3.83
October	57.3	34.4	45.8	4.28
November	45.9	27.9	36.9	3.98
December	34.4	17.2	25.8	3.95
Annual	55.1 (Average)	332.8 (Average)	43.9	47.26

The station normal report for the Cooperative Weather Observer in Sunderland indicates an average of one day per year when the maximum temperature would equal 90 degrees, 55 days when the maximum temperature would be less than 32 degrees and 172 days when the minimum temperature would be less than 32 degrees.

2. Extent and Location

Extreme temperature is a widespread phenomenon. The populations affected could be small if one is considering outdoor workers or the entire town in a power outage. Temperatures above 90^0F occur approximately one or two days per year. The highest recorded temperature from the Sunderland Cooperative Weather Observer station was 94^0F on June 1, 2011, which occurred again on July 22 and 23, 2011. The coldest recorded temperatures by the Sunderland Cooperative Weather Observer were -24^0 F on January 28, 2005, and -22^0 F recorded on both January 22 and 29 in 2005.

Average temperatures in Vermont have risen 2.7^0F since 1941 with an increase of 1.5^0F since 1990. Winter temperatures have risen more than summer temperatures. If these trends continue, the number of days above 90^0F will likely increase and minimum temperatures also increase (Galford et al 2014).

3. Probability, Impact and Vulnerability

Extreme heat is relatively rare with occurrences of approximately less than one day per year. Extreme cold, here defined as less than freezing temperature, is a frequent phenomenon in Vermont. Impacts of either type of event could be widespread, and vulnerability is dependent on the populations exposed.

F. Drought

1. Description

There are several types and definitions of drought: meteorological, climatological, atmospheric, agricultural and hydrological. The latter is based on stream flow and groundwater availability and is probably most important from a natural hazard assessment perspective. Reductions in precipitation over long enough periods, particularly during the growing season when plants take up moisture, can result in hydrologic drought.

2. Past Occurrences

The Palmer Hydrologic Drought Index (PHDI) is an indicator of potential surface and groundwater availability based on climatic conditions. The categories of drought include moderate drought, severe drought and extreme drought. Table 10 shows periods when the index showed severe and extreme droughts using data from 1985 to 2015. No drought conditions were recorded from 2003 through 2015.

Table 10. Years and number of months when the PHDI indicated severe or extreme droughts from 1895 to 2017.
Source: National Climate Data Center. Source: ftp://ftpncdd.noaa.gov/pub/data/cirs/climdiv/ (Richard Heims, personal communication)

Year	Extreme	Severe
1907		1
1908	2	1
1909	1	2
1910		2
1911	5	4
1912		2
1913		5
1914		5
1915	3	1
1921		2
1922		1
1930		1
1931		4
1941		5
1942		2
1949		1
1953		2
1957		1
1959		1
1963		3
1964	1	6
1965	8	1
1995		2
1999		1
2001	2	1
2002	1	1
2016		1
Total	23 months; 8 years	59 months; 27 years

3. Extent and Location

The National Climate Data Center calculates this index back to 1895. Since then, severe droughts occurred in 27 years or 22% while extreme droughts occurred in 8 years or 7%. Severe and extreme droughts have been of short duration, except occurrences in the early 1960s. Mild to moderate droughts have been more frequent. Severe and extreme droughts are likely to affect those properties with shallow wells. Based on well data from VT ANR, there are no wells in Glastenbury with depths less or equal to 100 feet.

4. Probability, Impact and Vulnerability

Based on the Palmer Drought Severity data, there is a 22% chance of a severe or extreme drought occurring in any one year. Existing wells are within areas of unconfined, overburdened aquifers. Except for long-term droughts, most wells should supply sufficient water, though structures with shallow wells are most likely to be affected. Droughts may affect the potential for wildfire, which is discussed below. Increasing temperatures or changes in precipitation patterns due to climate change may affect the frequency, length and degree of a drought.

G. Wildfire

1. Description

Wildfire or wildland fire is any unplanned fire affecting open lands including forests, grasslands or other features. The potential for wildland fire is dependent on fuel types, which vary with vegetation, topography and weather. Fire intensity, measured by the amount of energy released in a fire and exhibited by the length of flames, and rates of spread dictate the degree of wildland fire hazard and methods of control. Glastenbury participated with the towns of Arlington, Sunderland, Shaftsbury and Sandgate to complete a

community wildfire protection plan in 2013 (Batcher and Henderson 2013). The information from that plan has been incorporated into this section.

Table 11 shows how wildfires can be categorized based on size.

Table 11. Wildland fire size classes.
Source: National Wildfire Coordinating Group 2011

Magnitude (Size)	Description	Probability
Class A	< ¼ acre	High
Class B	¼ to 10 acres	High
Class C	10 to 100 acres	Moderate
Class D	100 to 300 acres	Low
Class E	300 to 1000 acres	Very low
Class F	1000 to 5000 acres	Very low
Class G	>5000 acres	Very low

In Vermont, forests tend to be dominated by northern hardwood species such as sugar maple (*Acer saccharum*), birch (*Betula* spp.), white pine (*Pinus strobus*) and hemlock (*Tsuga canadensis*). These species tend to create relatively low flammability fire, so that surface fires have low intensity and rates of spread, thereby limiting fire hazard (Anderson 1982). Most of the land area in Glastenbury is covered by broadleaf litter fuels that exhibit fires of low intensity and slow rates of spread (US Forest Service 2010).

Fire behavior is most extreme during periods when the relative humidity is low, generally less than 35-45%. These conditions are most prevalent in the spring, following snow melt, between March and late May or early June. After that, vegetation becomes increasingly green, and the resulting moisture in the live vegetation (fuel) reduces flammability significantly. Precipitation and evapotranspiration increase ambient relative humidity levels so that fires in the summer are generally rare and limited in size.

Fall again brings drying fuels and weather conditions increasing fire hazard. However, relative humidity levels increase after dark, and shorter days also limit the amount of time for fuels to dry and intense, fast moving fires to occur (North Central Research Station 2005).

In both forested and open settings, structures may be threatened by even small wildfires. These Wildland-Urban Interface (WUI) areas are the most likely areas where resources will be needed to suppress wildland fire, therefore the WUI is a major focus for wildland fire management planning, especially due to the increasing amount of development located in fire prone areas. The Federal Register (2001) defines the WUI as the area "…where humans and their development meet or intermix with wildland fuel." The predominant forest fuels in Glastenbury have very limited spotting distances (0.0 to 0.1 miles) while grass and grass shrub fuels range from 0.1 to 0.5 miles. Using the E911 sites from the Vermont Center for Geographic Information, we created three distances from E911 sites: 0.1, 0.2, and 0.5 miles (Map 6) to represent the WUI for this plan.

2. Past Occurrences

According to records from the Vermont Department of Forests, Parks and Recreation, from 1992 to 2015, 179 wildfires occurred in Bennington County, none of which occurred in the Town of Glastenbury. Burn permits were not issued by the forest fire warden during the dry periods of 2015 and 2016.

3. Extent and Location

Low intensity fires with relatively slow rates of spread could occur in the forested areas, which comprise most of Glastenbury's land cover. If fires were to occur on the steep slopes, it could present control problems due to the terrain and the rapid spread of the fires. Throughout the town, there may be pockets of heavier fuel loads, such as brush, or more flammable fuels, such as cured herbaceous vegetation and shrubs.

4. Probability, Impact and Vulnerability

Map 6 shows wildfire risk, as determined by the Vermont Department of Forests, Parks and Recreation (2010) and mean fire return interval from LANDFIRE. The fire return interval in forested areas in Vermont is generally greater than 100 years, meaning that the natural return interval is relatively long. This return interval is shorter for areas dominated by herbaceous vegetation in the fields within valleys, and these areas tend to be the locations of small, more frequent brush fires. Given that there has not been a wildfire on record in Glastenbury in over two decades, there is a 0-10% probability of one occurring in any given year.

The area's deciduous and coniferous forests create litter that is relatively low in flammability so that wildfires have relatively low intensity and rates of spread. The main hazard is for wildland fire fighters working in steep terrain. The natural fire return intervals in most forests in Vermont are greater than 50 years (Malamud et al 2005) and greater as shown in Map 6. Recurrence is likely related to precipitation rather than the buildup of fuels, so drought recurrence is already factored into these interval estimates. Therefore, the potential for large fires is very limited due to the fuel characteristics. However, large roadless areas and steep topography can make suppressing wildland fires that do occur in Glastenbury very difficult. The settled areas have a low vulnerability to fire.

H. Earthquake

1. Description

Vermont has no active faults, but has experienced minor earthquakes. Table 12 below shows the most recent occurring within the state, though there have been others located outside the state that have been felt in Vermont (Springston and Gale 1998). The U.S.

Geological Survey predicts a two percent probability of an earthquake causing considerable damage in Vermont sometime in the next 50 years (Springston and Gale 1998).

2. Past Occurrences

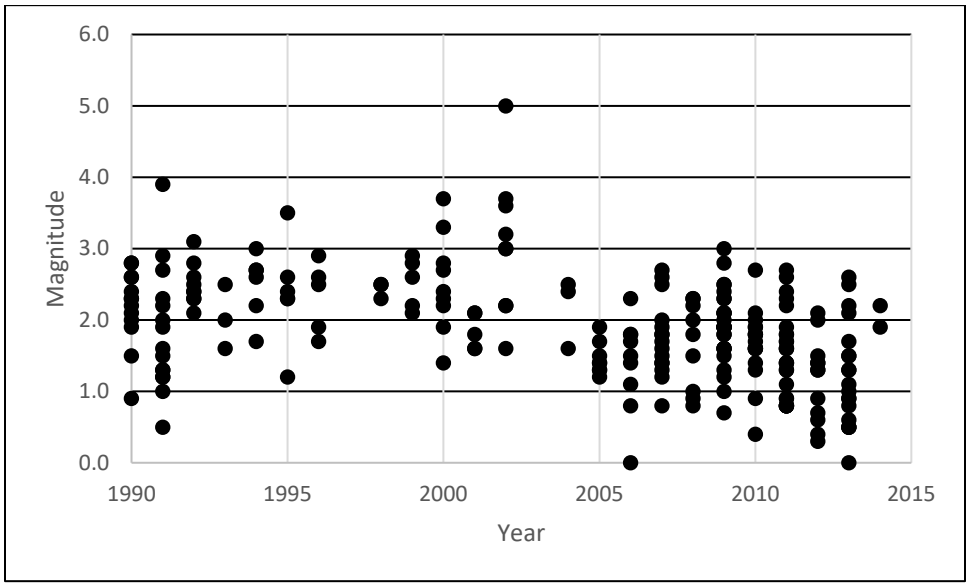
Data from the Weston Observatory at Boston College (Northeast Earthquake Maps and Catalog) was used to identify earthquakes occurring within 100 miles of Glastenbury since 1990. No earthquakes occurred in either Glastenbury or Bennington County during that period. Figure 3 below plots the number of earthquakes by year by magnitude.

Table 12. Earthquake magnitude and intensity scale descriptions.
Source: http://earthquake.usgs.gov/learn/topics/mag_vs_int.php

Magnitude	Modified Mercalli Intensity	Description
1.0-3.0	I	I. Not felt except by a very few under especially favorable conditions
3.0- 3.9	II-III	**II**. Felt only by a few persons at rest, especially on upper floors of buildings. **III**. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck.
4.0-4.9	IV-V	**IV**. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably. **V**. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
5.0-5.9	VI-VII	**VI**. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. **VII**. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
6.0-6.9	VII-IX	**VII**. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken. **VIII**. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. **IX**. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.

Table 12. Earthquake magnitude and intensity scale descriptions. Source: http://earthquake.usgs.gov/learn/topics/mag_vs_int.php		
Magnitude	Modified Mercalli Intensity	Description
7.0 and higher	VIII or higher	**VIII**. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. **IX**. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations. **X**. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent. **XI**. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly. **XII**. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Figure 3. Plot of earthquakes and magnitude for occurrences within 100 miles of Bennington County, VT. Source: Northeast Earthquake Maps and Catalog 2018



3. Extent and Location

Table 13 shows earthquakes that have occurred in Vermont based on the 1995 report. No earthquakes have been recorded in Glastenbury or in Bennington County. Those occurring within 100 miles have ranged in magnitude from barely registered to 5.0, with most in the range of 1.0 to 3.0 (Figure 3). No damage was recorded in any of these in Glastenbury. In 2003, the Vermont Geological Survey completed simulations using FEMA HAZUS software of potential damage within Bennington County from a 500-year recurrence earthquake centered in

Middlebury, VT, Tamworth, NH and Goodnow, NY. The results indicated minimal damage and injury from any of these events to Glastenbury (Kim 2003).

Table 13. Earthquakes in Vermont.
Source: Vermont Geological Survey (Ebel et al 1995)
http://www.anr.state.vt.us/dec/geo/EBEL.htm consisting of excerpts from: A Report on the Seismic Vulnerability of the State of Vermont by John E. Ebel, Richard Bedell and Alfredo Urzua, a 98 page report submitted to Vermont Emergency Management Agency in July, 1995.

Location	Date	Magnitude	Mercalli Intensity
Swanton	July 6, 1943	4.1	Felt by nearly everyone; many awakened with some dishes and windows broken and unstable objects overturned
Brandon	March 31, 1953	4.0	Felt indoors by many, but by few outdoors. Sensation would be similar to a heavy truck striking a building
Middlebury	April 10, 1962	4.1	Felt by nearly everyone; many awakened with some dishes and windows broken and unstable objects overturned

4. Probability, Impact and Vulnerability

Based on the 2003 HAZUS analyses, both the probability and impact of an earthquake occurring with a magnitude large enough to cause substantial damage in Vermont is low. However, earthquake prediction science is very limited.

I. Landslide

1. Description

Landslides are typically associated with periods of heavy rainfall or rapid snow melt and tend to worsen the effects of flooding that often accompanies these events. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly. Gravity is the force driving landslide movement. Factors that allow the force of gravity to overcome the resistance of earth material to landslide movement include saturation by water, steepening of slopes by erosion or construction, and alternate freezing or thawing. Table 14 shows how landslides can be categorized.

Table 14. Landslide and debris flow types. Source: U.S. Geological Survey 2006		
Magnitude	Description	Probability
Localized	Falls: abrupt movements of rocks and boulders, generally on steep slopes.	Low to moderate
Topples	Topples: movements involving some forward rotation as material moves downhill.	Low to moderate
Flows	A range of land movement generally involving a mass of loose soil, rock, organic matter, air and water moving downhill rapidly and possibly covering a wide area. One form called creep involves slow movement of material and is often recognizable by trees growing so as to remain vertical while bent near the ground as they grow to keep up with the slow material flow.	Highly variable but can be fairly common.

2. Past Occurrences

No landslides were reported during Tropical Storm Irene and none have been reported from previous or subsequent storm events. No rockfall areas were identified by the Vermont Agency of Transportation (Eliason and Springston 2007).

3. Extent and Location

Using a protocol developed for the Vermont Geological Survey (Clift and Springston 2012), Dale (2015) used geographic information system data and analyses to develop a potential landslide map for the town. Map 7 shows that the areas of medium and high potential for landslides are primarily on the steeper slopes of the Green Mountains. These are located a great distance from settled areas, the road system and other infrastructure.

4. Probability, Impact and Vulnerability

While Map 7 shows areas of high potential for landslides in higher elevations, the probability of the identified areas affecting settled areas is low, and therefore the potential impact and vulnerability are both low.

J. Invasive Species

1. Descriptions

Invasive species are organisms that are not native to a geographic area and which can or do cause economic or environmental harm. Invasive species are characterized by organisms that spread rapidly, can displace native species, and have few or no predators to keep their populations in check. At the same time, they have characteristics that may reduce the value and use of natural resources. Japanese knotweed colonizes stream banks, and does not hold soil well, leading to increased streambank erosion. Bush honeysuckle can become a dominant shrub in some forests, reducing the potential for tree regeneration (Vermont Invasives 2016).

Vermont has two invasive species lists: Class A species are on the Federal Noxious Weed List but are not known to occur in Vermont. These are listed in 7 C.F.R. 360.200, a section of the Code of Federal Regulations. Class B species are known to occur in the state and are considered a threat (Table 15). The table also indicates species observed in Glastenbury.

Table 15. Designated Class B noxious weeds in Vermont. Source: Vermont Agency of Agriculture, Food and Markets:
Sources:
http://agriculture.vermont.gov/plant_pest/plant_weed/invasive_noxious_weeds/noxious_weeds_list
Those with a * have been identified in Bennington County through the Early Detection and Mapping System: http://www.eddmaps.org/tools/query/
Those marked with ** have been identified in Pownal either by Michael Batcher of BCRC or Shelly Stiles of the Bennington County Conservation District
Those marked with an (A) are also on the aquatic invasive species list (Table 16)

Scientific Name	Common Name
*Acer ginnala**	Amur maple
*Acer platanoides**	Norway maple
*Aegopodium podagraria**	Bishop's goutweed or goutweed
Ailanthus altissima	Tree of heaven
*Alliaria petiolata**	Garlic mustard
*Berberis thunbergii**	Japanese barberry
*Berberis vulgaris**	Common barberry
Butomus umbellatus (A)	Flowering rush
*Celastrus orbiculatus**	Oriental bittersweet
*Euonymus alatus**	Burning bush
*Fallopia japonica**	Japanese knotweed
Hydrocharis morsus-ranae (A)	Frogbit
*Iris pseudacorus** (A)	Yellow flag iris
Lonicera japonica	Japanese honeysuckle
Lonicera maackii	Amur honeysuckle
*Lonicera morrowii** **	Morrow honeysuckle
*Lonicera tatarica**	Tartarian honeysuckle
*Lonicera x bella**	Bell honeysuckle
*Lythrum salicaria** ** (A)	Purple loosestrife
*Myriophyllum spicatum** (A)	Eurasian watermilfoil

Table 15. Designated Class B noxious weeds in Vermont. Source: Vermont Agency of Agriculture, Food and Markets: Sources: http://agriculture.vermont.gov/plant_pest/plant_weed/invasive_noxious_weeds/noxious_weeds_list Those with a * have been identified in Bennington County through the Early Detection and Mapping System: http://www.eddmaps.org/tools/query/ Those marked with ** have been identified in Pownal either by Michael Batcher of BCRC or Shelly Stiles of the Bennington County Conservation District Those marked with an (A) are also on the aquatic invasive species list (Table 16)	
Scientific Name	Common Name
Najas minor (A)	European naiad
Nymphoides peltata (A)	Yellow floating heart
*Phragmites australis** (A)	Common reed
Potamogeton crispus (A)	Curly leaf pondweed
*Rhamnus cathartica**	Common buckthorn
*Rhamnus frangula**	Glossy buckthorn
*Trapa natans** (A)	Water chestnut
*Vincetoxicum nigrum **	Black swallow-wort

The bush honeysuckles (*Lonicera* spp.) have been observed along roadsides. Buckthorn (*Rhamnus cathartica*) and Japanese barberry (*Berberis thunbergii*) have invaded forests and wetland edges and Japanese knotweed (*Fallopia japonica*) has invaded stream banks and other disturbed areas. Table 16 shows aquatic invasive species listed by the Vermont Agency of Natural Resources.

Table 16. Aquatic invasive species in Vermont. Source: Watershed Management Division, Department of Environmental Conservation: http://www.vtwaterquality.org/lakes/htm/ans/lp_ans-index.htm	
Scientific Name	Common Name
Dreissena polymorpha	Zebra mussel
Alosa pseudoharengus	Alewife
Orconectes rusticus	Rusty crayfish
Bythotrephes longimanus	Spiny Waterflea
Corbicula fluminea	Asian clam
Didymosphenia geminata	Didymo[1]
Nitellopsis obtusa	Starry Stoneword
Myriophyllum heterophyllum	Variable-leaved Watermilfoil

2. Past Occurrences

Invasive species are present and represent a continuous hazard that will vary with their abundance and their impacts on structures and infrastructure.

[1] Recently this species has been determined to be native, but that status may change.

3. Extent and Location

The extent of invasive plants in Glastenbury and in Bennington County has not been fully mapped. In addition to the species listed above, the following are should be considered invasive species:

Pastinaca sativa (wild parsnip) is abundant along roadsides and can cause skin burns when chemicals in the plant on exposed skin interact with sun, which can harm those who work on or along roads or utility rights of way. *Anthriscus sylvestris* (cow parsnip or wild chervil) also dominates roadsides and can invade meadows. *Phalaris arundinacea* (reed canary grass) can invade wetlands and crowd out native plants and has been observed. *Rosa multiflora* (multiflora rose), while not listed as an invasive, is an invasive species in many states and has invaded roadsides.

Insects and pathogens have the potential for dramatically altering the composition and structure of forests as well as affecting trees in settled areas. *Adelges tsugae* (hemlock wooly adelgid) has dramatically reduced hemlock trees south of Vermont and was recently found in Pownal, Vermont. *Agrilus planipennis* (emerald ash borer) is a significant threat to forests as it kills all ash species. Borers are often dispersed through movement of firewood.

In addition to the above insects, there are other insects and pathogens that are affecting Vermont forests. These may constitute an emerging hazard (Schultz et al 2015). Climate change may increase the abundance and ranges of forest pest species such as hemlock wooly adelgid and invasive species currently found in more southerly locations (Rustad 2012).

4. Probability, Impact and Vulnerability

The likelihood of increased abundance of invasive species is 75-100% and potential impacts to forested areas are very high. Invasive insects that can cause tree death, particularly the emerald ash borer, could result in road closures, power outages and property damage. Increases in the abundance of invasive plant species could limit regeneration of native trees and shrubs and affect the long term integrity of the forests (Vermont Department of Forests, Parks and Recreation 2010, Vermont Invasives 2016).

K. Hazardous Material Spill

1. Descriptions

Hazardous wastes are materials that are flammable, corrosive, toxic, or labeled with warning or caution labels. These materials are used in industry, in the home or on farms and are transported regularly.

2. Past Occurrences

The Vermont spill site list indicates there have been 2 spills reported in Glastenbury since 1973, and these are listed in Table 17 below.

Table 17. Hazardous Materials Spills in Glastenbury, VT.
Source: Vermont Agency of Natural Resources: https://anrweb.vt.gov/DEC/ERT/Spills.aspx

Report #	Year	Facility Name	Address	Nature of Incident	Product Released	Quantity	Responsible Party
WMD427	2018	Paula Ann Ligouri Residence	Not specified	Tank seam split while filling tank	#2 Fuel Oil	50 gallons	Paula Ligouri
WMD395	2015	Logging Road	Logging Road off Glastenbury. Rd	Release from logging Truck	Diesel	Unknown	Mike Cromwell
WMD040	2013	Roadway	RT 7 North	Hydraulic Equipment Failure	Hydraulic Fluid	30 gallons	VTrans

3. Extent and Location

The spills listed in Table 17 affected small sites or areas. US Route 7 carries substantial traffic, and a spill on this road could affect a large portion of the town and create long traffic delays. Of particular concern in any hazardous materials spill would be the impact on water resources. Map 8 shows the transportation system in relation to surface waters including streams and wetland and groundwater protection areas. Roads with average grades greater than 10% also present hazards, particularly when roads are wet or during winter storms.

4. Probability, Impact and Vulnerability

Hazardous materials spills occur less than annually and affect very small areas. Increased truck traffic on US Route 7 increases the possibility of a major spill, and many areas are vulnerable due to the proximity of surface and groundwater resources. Most hazardous materials are transported via US Route 7. However, Glastenbury Road carries materials that could spill and affect aquatic resources, as well as individual wells.

The overall likelihood of a hazardous materials spill on an annual basis is probably 1-10%, since they do not occur yearly. Injuries, except in the case of direct injuries from a traffic accident, are likely low. However, the long-term impacts of a spill could be extensive if aquatic resources and/or water supplies were affected.

L. Infectious Disease Outbreak

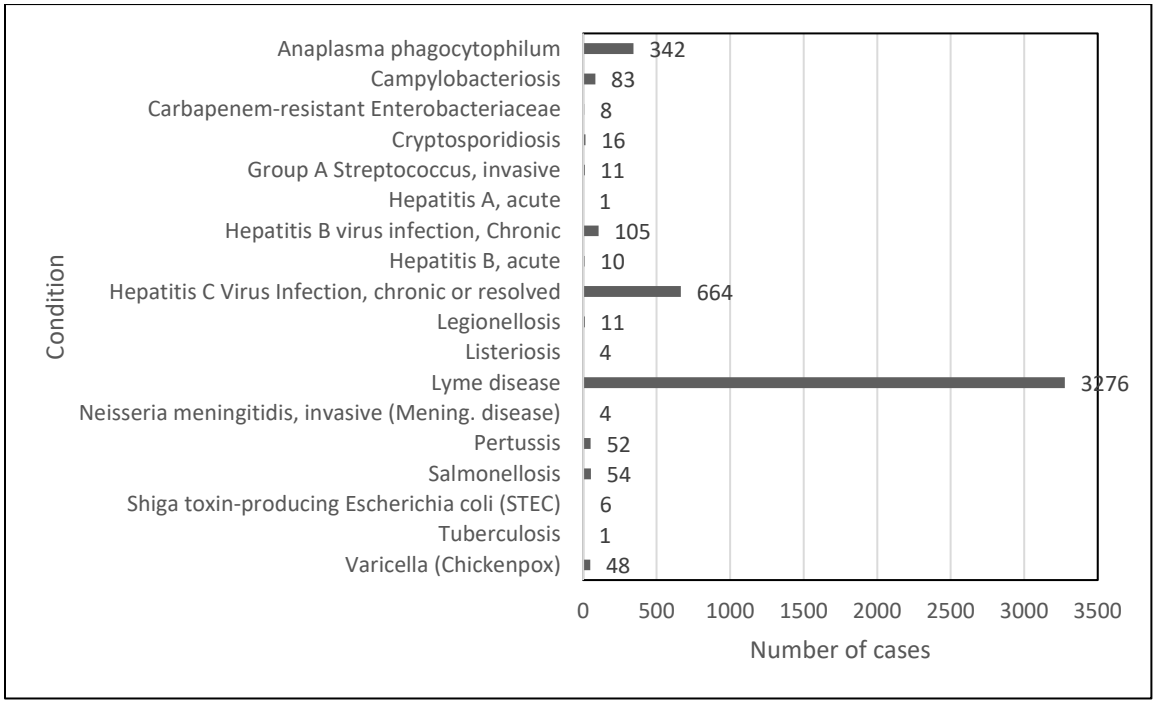
1. Descriptions

Infectious diseases are caused by bacterial infections, viruses, fungi and other organisms that can spread through the human population.

2. Past Occurrences

The most prevalent infectious disease in Bennington County, tracked by the Vermont Department of Health, has been Lyme disease, carried by and transmitted by ticks. The symptoms can range from minor to very severe, and are a clear threat to anyone in the town. Figure 4 shows the diseases tracked by the Vermont Department of Health.

Figure 4. Disease cases in Bennington County from 2006 to 2017. Source: Veronica Fialkowski, Vermont Department of Health



3. Extent and Location

In general, individuals and families are most affected by infectious diseases, but schools and businesses could be affected as well.

4. Probability, Impact and Vulnerability

Given past history, there is a low probability of a disease affecting a large portion of the town, but high probability of continued, isolated occurrences. Lyme disease and other tickborne diseases could affect residents and those using recreational trails and visiting natural areas.

V. Vulnerability Assessment

A. Prioritization of Hazards

The information described above was used to prioritize hazards using criteria from the Vermont Hazard Mitigation Plan as described in Table 18 below.

Table 18. Vulnerability assessment factors (Vermont Hazard Mitigation Plan 2014)
Frequency of Occurrence: Probability
1 = Unlikely <1% probability of occurrence per year
2 = Occasionally 1–10% probability of occurrence per year, or at least one chance in next 100 years
3 = Likely >10% but <100% probability per year, at least 1 chance in next 10 years
4 = Highly Likely 100% probability in a year
Warning Time: Amount of time generally given to alert people to hazard
1 = More than 12 hours
2 = 6–12 hours
3 = 3–6 hours
4 = None–Minimal
Geographic Area Affected: How large an area would likely be affected?
1 = Community-wide
2 = State-wide
3 = Region-wide
Potential Impact: Severity and extent of damage and disruption
1 = Negligible Isolated occurrences of minor property damage, minor disruption of critical facilities and infrastructure, and potential for minor injuries
2 = Minor Isolated occurrences of moderate to severe property damage, brief disruption of critical facilities and infrastructure, and potential for injuries
3 = Moderate Severe property damage on a neighborhood scale, temporary shutdown of critical facilities, and/or injuries or fatalities
4 = Major Severe property damage on a metropolitan or regional scale, shutdown of critical facilities, and/or multiple injuries or fatalities

B. List of Priority Hazards

The planning team reviewed each of the potential natural hazards that could affect Glastenbury as described in Section IV. They then scored the hazards based on the criteria in Table 18 to determine which hazards would need mitigation actions. Table 19 shows the results of the scoring, with Flood and Flash Floods, Winter Storms, High Wind Events, Drought, Hazardous Materials Spills, Infectious Diseases and Invasive Species ranked highest. Geographic

area affected and potential impacts were key criteria in determining whether or not mitigation actions would be developed for specific hazards. The planning team determined that, while earthquakes ranked high, the score was likely due to the short warning time and, therefore, was not an accurate representation of the threat of this hazard.

Table 19. Vulnerability assessment

Hazard	Number of Events	Frequency of Occurrence	Geographic Area Affected	Warning Time	Potential Impacts	Total Score
Floods and Flash Floods	50 events from 1996 to 2017	3	3	2	3	11
Winter Storms	162 events from 1996 to 2017	4	3	1	3	11
High Wind Events	131 events from 1996 to 2017	3	1	3	3	10
Hail	30 events from 1996 to 2017	3	1	3	1	8
Temperature Extremes	Annual >90 F – 1 day on average Annual maximum <32 F – 55 days Annual minimum < 32 F – 172 days	96	2	1	1	5 (>90 F) 8 (<32 F)
Drought	Severe droughts have occurred in 27 years from 1895 to 2017	3	3	1	2	9
Wildfire	179 wildfires in Bennington County from 1992 through 2015; none in Glastenbury	1	1	4	1	7
Landslides and Debris Flows	No records	1	1	4	1	7
Earthquake	No events causing damage	1	3	4	2	10
Hazardous Materials Spills	3 events from 1973 to early 2017	3	1	4	2	10
Infectious Disease Outbreak	Annual	4	3	1	3	11
Invasive Species	Ongoing	4	3	1	2	10

Map 8 is composite map showing river corridors, roads with medium or high erosion potential (hydrologically connected road segments), damages documented during Tropical Storm Irene, and areas needing culvert upgrades. Other priority hazards such as invasive

species or infectious diseases were not mapped either as adequate surveys have not been completed, or they could affect the entire towns.

There are no concentrations of vulnerable populations such as mobile homes or senior housing developments. Mobile home dwellers are often the most vulnerable to natural hazards (Vermont Department of Housing and Community Development 2013).

VI. Mitigation Measures

A. Hazard Mitigation Goals

As part of the planning process, the Glastenbury identified the following mitigation goals:

1. Reduce injury and loss of life resulting from natural disasters.
2. Reduce damage to public infrastructure, minimize disruption to the road network and maintain both normal and emergency access.
3. Establish and manage a program to proactively implement mitigation projects for roads, bridges and culverts to ensure that community infrastructure is not significantly damaged by natural hazard events.
4. Design and implement mitigation measures so as to minimize impacts to rivers, water bodies and other natural features.
5. Increase the economic resiliency of Glastenbury by reducing the economic impacts incurred by municipal and residential assets due to disasters.
6. Incorporate hazard mitigation planning into other community planning projects, such as the Town Plan.
7. Ensure that members of the general public continue to be part of the hazard mitigation planning process.

B. 2015 Glastenbury Town Plan

The 2015 Town Plan (Town of Glastenbury 2015) includes goals for the prohibition of developments that would adversely affect special resource areas or unique natural features, protecting prime agricultural lands and ridges and mountaintops, and protecting ground and surface water resources. As shown in Map 3, development should be concentrated along Glastenbury Road. Higher elevations and forested areas would be maintained for forestry, hunting and recreational uses. Protection of these forested areas should help reduce the amount and velocity of water in the upper reaches of streams leading to the Batten Kill, the Walloomsac River and the Deerfield River thereby increasing flood resilience.

C. State and Regional Plans and Programs

1. Vermont Hazard Mitigation Plan (2013)

The Vermont Hazard Mitigation Plan (Vermont Division of Emergency Management and Homeland Security 2013) identified a series of hazards shown in Table 20 below along with those we considered in this plan. The planning team used the state plan as a starting point and local knowledge to create a more specific set of hazards that they addressed. Table 20 shows how the Glastenbury plan tracks the state plan except where some hazards were combined and a few, including nuclear plant accident, were not considered.

Table 20. Comparison of hazards considered in the Vermont Hazard Mitigation Plan vs. the Glastenbury Hazard Mitigation Plan

VT Hazard Mitigation Plan	Glastenbury Hazard Mitigation Plan
Atmospheric Hazards	**Natural Hazards**
Drought	Drought
Earthquake	Earthquake
Flooding	Flooding and Fluvial Erosion
Fluvial Erosion	See Flooding and Fluvial Erosion
Hail	Hail
High Winds	High Winds
Hurricane/Tropical Storm	See High Winds and Flooding and Fluvial Erosion
Ice Storm	See Severe Winter Weather/Ice Storm
Ice Jams	See Flooding and Fluvial Erosion
Infectious Disease Outbreak	Infectious Disease Outbreak
Landslide/Debris Flow	Landslide/Debris Flow
Severe Thunderstorm	See High Winds and See Flooding and Fluvial Erosion
Severe Winter Weather	Severe Winter Storms
Temperature Extremes	Temperature Extremes
Tornado	See High Winds
Wildfire	Wildfire
Technological Hazards	**Technological Hazards**
Dam Failure	See Flooding and Fluvial Erosion
Hazardous Materials Spill	Hazardous Materials Spill
Invasive Species	Invasive Species
Nuclear Power Plant Accident	Not addressed
Rock Cuts	See Landslide
Terrorism	Not addressed

The Vermont Hazard Mitigation Plan identified flooding and fluvial erosion, winter storms, high winds and severe thunderstorms as high risk hazards for Bennington County and radiological accidents and hazardous materials spills as moderate risk.

2. Bennington County Regional Plan Policies and Actions (adopted March 19, 2015)

The Bennington County Regional Plan (Bennington County Regional Commission 2015) lists the following policies and actions supporting hazard mitigation including several policy recommendations emphasizing protecting natural resources, maintaining village and urban centers and avoiding development on sensitive lands including areas of steep slope and wetlands along with the protection of surface and groundwater resources and forested lands (Sections VII and VIII). The regional plan also includes a flood resilience section (IX), which is required by Vermont statutes describing potential hazards from flooding and fluvial erosion. The section encourages avoiding development in flood hazard areas, reconstruction of bridges and culverts that impede flows, undisturbed buffer areas along streams to provide for lateral movement and attenuation of overland flow, participation in the National Flood Insurance Program, updating of flood bylaws, adoption of up to date road and bridge standards and participation in the community rating system.

3. Vermont Agency of Natural Resources

The Vermont Agency of Natural Resources (VT ANR) has mapped river corridors and can regulate activities within those that are not subject to review by municipalities. VT ANR also reviews municipal permit applications for stream alterations, regulated activities within wetlands, and permits for transporting hazardous materials.

4. Act 250 Review

The Act 250 program provides a public, quasi-judicial process for reviewing and managing the environmental, social and fiscal consequences of major subdivisions and developments in Vermont. During Act 250 proceedings, agencies and the public can offer comments on such proposed developments.

5. Other Organizations

Phase I and II geomorphic assessments and a river corridor plan (Field 2007) have been completed for the Batten Kill and its major tributaries listing restoration actions. These were integrated into the Batten Kill Walloomsac Hoosic Tactical Basin Plan (Vermont Agency of Natural Resources 2016). The Bennington County Regional Commission, Bennington County Conservation District, the Batten Kill Watershed Alliance and Vermont Agency of Natural Resources have been working to implement the actions in the river corridor plan.

D. Current Programs Supporting Mitigation

Glastenbury adopted a revised zoning ordinance in 2006 which:

- prohibits development within 100 feet of the top of bank of any stream
- prohibits development that might negatively impact groundwater resources
- limits use of the Forest and Recreation 2 Zoning District to silviculture, hunting camps, and forest and recreation uses to maintain forested lands

E. Town Capabilities

Glastenbury has a town supervisor, planning commission, zoning administrator, a forest fire warden and an emergency management director providing capabilities for implementation of this hazard mitigation plan. The town supervisor serves as the legislative body and appoints the planning commission, zoning administrator, forest fire warden and emergency management director. The zoning administrator is responsible for investigating possible public health hazards and risks within the Town of Glastenbury, taking action to prevent, remove or destroy any such hazards, taking action to mitigate significant public health risks and enforcing health laws, zoning regulations and permit conditions. Fire protection in Glastenbury is administered and coordinated by the Glastenbury Forest Fire Warden. The fire protection falls into two categories: fire protection for the Green Mountain National Forest, and fire protection for private property. Fire protection for the National Forest lands is provided through the Shaftsbury and Arlington Volunteer Fire Departments. Fire fighting equipment and a jeep are provided by the U.S.F.S. First response for fires on private property comes from the Shaftsbury Volunteer Fire Department. Mutual aid, as required, is coordinated through the Shaftsbury Fire Chief. Glastenbury relies on the Arlington Rescue Squad for emergency services. The town does not maintain a police force but receives patrols and protection from the Vermont State Police located in Shaftsbury. The Vermont Agency of Transportation has jurisdiction over Glastenbury Road and US Route 7 and maintains the roadways, bridges, culverts and ditches.

Table 21 below summarizes the capabilities of Glastenbury and areas needing improvement to enhance those capabilities.

Table 21. Capabilities of the Town of Glastenbury			
Plans, Policies, Ordinances	Description/Responsible Agent	Effectiveness	Improvements Needed
Town Plan	Planning Commission; Emergency Management Director and Emergency Management Coordinator; Town Supervisor (approval of Town Plan)	Low effectiveness; current Town Plan does not specifically address Emergency Management	Draft new sections of Town Plan on Emergency Management (in 2019 for adoption 2020).
Zoning Bylaws	Planning Commission; Zoning Board and Zoning Administrator (permitting); Town Supervisor (approval of bylaws)	Needs some improvements and updates	Adoption of river corridor protection.
Mutual Aid for Emergency Services	Emergency Management Director and Emergency Management Coordinator; Town Supervisor (approval of agreements); LEPC (coordination)	High effectiveness, recently updated	Update mutual aid fire agreements with neighboring communities.
Mutual Aid for Public Works	Emergency Management Director and Emergency Management Coordinator; VTRANS; Town Supervisor (approval of agreements); LEPC (coordination)	Needs some improvements and updates	Update mutual aid agreements for DPW.
Zoning/Subdivision Regulations	Planning Commission (development of bylaws); Zoning Administrator (permitting); Town Supervisor (approval of bylaws)	Effective	Review regulations as part of upcoming rewrite of Town Zoning Bylaws; continued training of volunteer board members to ensure effective permitting and Zoning Administrator.
Wetlands/Rivers and Streams/Waterbodies/Steep Slopes/Groundwater Protection Regulations	Planning Commission (development of bylaws); Zoning Administrator (permitting); Town Supervisor (approval of bylaws)	Effective; Town requires 50 foot setback from surface water and 100 foot from steep slopes	Review regulations as part of upcoming rewrite of town land use and development ordinance; continued training of volunteer board members to ensure effective permitting and Zoning Administrator.
Building Codes	State of Vermont (commercial only); Zoning Administrator	Commercial building codes overseen by State of Vermont (Department of Public Safety)	Town does not oversee building codes for residential structures.
Road Maintenance Programs and Standards	VTRANS; Town Supervisor	Effective; town adopted most recent State of Vermont (AOT) Town Road and Bridge Standards	Enact new roads and bridge ordinance; update culvert and bridge inventory; conduct road erosion inventory.

Table 21. Capabilities of the Town of Glastenbury			
Plans, Policies, Ordinances	Description/Responsible Agent	Effectiveness	Improvements Needed
Events Management	Emergency Management; Police Department	Town events involve emergency planning; other events currently do not	Enact Special Events Ordinance; delegation coordination and permitting to State Police.

F. Mitigation Actions

Table 23 below lists mitigation actions for each of the hazards. Some will be implemented by the Town of Glastenbury and others by agencies such as the Vermont Agency of Transportation. Mitigation actions are listed by the type of hazard. To determine the priority, the Planning Team first used Vulnerability Assessment they completed and which is shown in Table 19. They then used the criteria in Table 22 below to rank actions based on their best available information and best judgment.

Many of the actions shown in Table 23 would need further study and design work. Prior to the implementation of any action using funding from FEMA, a benefit-cost analysis would be completed to assure the action would be feasible and cost-effective.

Table 22. Ranking of mitigation actions

Criteria	Ranking (score in parentheses)
Potential vulnerability from hazard	High (3): risk assessment score Medium (2): risk assessment score Low (1): risk assessment score
Potential protection of life and degree of reduction in damage by action	High (3): greater than 50% reduction in estimated damage, loss of life or injury Medium (2): 25-50% reduction in estimated damage, loss of life, or injury Low (1): less than 25% reduction in estimated damage, loss of life or injury
Consistency of the action with town goals and plans	High (3): goals are consistent with existing town plans Low (1): goals are inconsistent with existing town plans
Degree of technical feasibility of the proposed action	High (3): project is technically feasible Low (1): feasibility is low
Implementation costs	High (3): project could be implemented for less than $25,000 Medium (2): project would cost between $25,000 and $100,000 Low (1): project costs would exceed $100,000
Ability of the town to implement the proposed action in terms of administrative capability and legal authority	High (3): Town has current capability to implement the action Medium (2): Town would need to expand capability while implementing action through contractors or additional staffing Low (1): Town would need extensive assistance to implement action
Degree of local support for the action	High (3): the community supports the proposed action Low (1): the project is opposed in the community
Potential costs to natural systems of implementing the action	High (3): natural systems would not be affected, would be enhanced by the action or be affected to a minimal degree Medium (2): natural systems would be affected by impacts could be mitigated or reduced Low (1): natural systems would be negatively impacted and those impacts could not be mitigated or reduced
Potential costs to cultural resources of implementing the action	High (3): cultural resources would not be affected Medium (2): cultural resources would be affected by impacts could be mitigated or reduced Low (1): cultural resources systems would be negatively impacted and those impacts could not be mitigated or reduced
Potential costs to social and economic resources of implementing the action	High (3): social and economic resources would either be unaffected or enhanced by the project

Table 22. Ranking of mitigation actions	
Criteria	Ranking (score in parentheses)
	Medium (2): economic and social resources would be affected by impacts could be mitigated or reduced Low (1): economic and social resources would be negatively impacted and those impacts could not be mitigated or reduced

Table 23. Mitigation Actions. Type is based on categories from the Federal Emergency Management Agency 2013b						
Hazard	Type	Action	Responsible Party	Time Frame	Funding Source(s)	Priority
All Hazards	Local Planning and Regulations	Encourage proper construction techniques and use of appropriate materials to address hazards, particularly winter storms, wind events, earthquakes, landslides and wildfire	Town Planning Commission; Zoning Administrator	2019 to 2020	Town general fund	High
All Hazards	Local Planning and Regulations	Integrate this hazard mitigation plan into the Town Plan and budgeting and capital improvements plan	Town Supervisor; Town Planning Commission; Zoning Administrator	2019 to 2024 (ongoing)	Town general fund	Medium to High
All Hazards	Education and Awareness	Identify and develop methods to communicate with populations vulnerable to potential hazards, particularly drought, extreme temperatures and infectious diseases, but also those in need of assistance for evacuation and/or sheltering	Town Emergency Management Coordinator	2019 to 2020	Town general fund	High
All Hazards	Local Planning and Regulations	Assess need for driveway standards to assure adequate emergency access particularly to assure adequate access in winter storms, floods and for wildfire protection	Town Planning Commission	2019 to 2020	Town general fund	High
Floods and Flash Floods	Local Planning and Regulation	Develop and incorporate flood resiliency section, including sections addressing the protection of surface waters, land adjacent to streams, wetlands and water bodies, upland forests and other lands necessary to provide flood resiliency into the Glastenbury Town Plan as required by Vermont statutes	Town Planning Commission; BCRC	2019 to 2020	Town general fund; Municipal Planning Grant	Medium to High
Floods and Flash Floods	Local Planning and Regulation	Develop a watershed planning team with other towns within the Batten Kill watershed to coordinate planning and other actions to protect the river and promote flood resilience	Town Planning Commission; BCRC	2020 to 2024	Town general fund; Watershed Grant from VT ANR	Medium

Table 23. Mitigation Actions. Type is based on categories from the Federal Emergency Management Agency 2013b						
Hazard	Type	Action	Responsible Party	Time Frame	Funding Source(s)	Priority
Floods and Flash Floods	Local Planning and Regulations	Encourage appropriate stormwater and erosion control measures	Town Planning Commission; VTRANS	2019 to 2023 (ongoing)	Town general fund	High
Floods and flash floods	Local Planning and Regulations	Adopt the latest Vermont Town Road and Bridge Standards	Town Supervisor	2019 to 2020 and as updated	Town general fund	High
Floods and Flash Floods	Local Planning and Regulations	Inventory roads for stormwater mapping as part of the Vermont Stormwater program	BCRC	2020 to 2023	VT Better Roads; Town General Fund	High
Floods and Flash Floods	Local Planning and Regulations	Complete town-wide stormwater management plan in accordance with the Vermont Stormwater Manual	BCRC	2020 to 2023	VT Better Roads; Town General Fund	High
Floods and Flash Floods	Local Planning and Regulations	Update culvert inventory	BCRC	2020 to 2023	Town General Fund; VT Better Roads	Medium
Floods and flash floods	Natural Systems Protection	Complete inventory of road network to assess whether road segments connected to surface waters through ditches, culverts or other drainage structures meet the new stormwater standards required by the Municipal Road General Permit	BCRC	2020 to 2022	Town General Fund; VT Better Roads	High
Floods and flash floods	Natural Systems Protection	Develop a long-term plan to bring all sections of connected roads to revised standards as part of the Municipal Road General Permit	BCRC	2020 to 2022	Town General Fund; VT Better Roads	High
Floods and Flash Floods	Natural Systems Protection	Implement stormwater management projects identified as part of the Municipal Road General Permit planning	BCRC; Bennington County Conservation District; VTRANS	2020 to 2023 and beyond	Town general fund; State of VT; FEMA HMGP, PDM, FMA	High

Table 23. Mitigation Actions. Type is based on categories from the Federal Emergency Management Agency 2013b						
Hazard	Type	Action	Responsible Party	Time Frame	Funding Source(s)	Priority
Floods and flash floods	Structure and Infrastructure projects	Road crew should regularly survey culverts for blockages including photographs and records of damages and costs	VTRANS	2020 to 2024 (ongoing)	Town highway fund	High
Floods and flash floods	Structure and infrastructure protection	Implement corridor protection, buffer plantings, structure and berm removal and other projects listed in the Batten Kill Walloomsac Hoosic Tactical Basin Plan and, where applicable, in the 2007 Batten Kill corridor plan	Town Supervisor; Batten Kill Watershed Alliance Basin Planning Team	2020 to 2025 (ongoing)	FEMA HMGP, FMA, PDM; Vermont Ecosystem Restoration Program; Vermont Watershed Grant	Medium to High
Floods and flash floods	Structure and infrastructure projects	Identify and replace culverts and bridges that do not meet current Vermont Town Road and Bridge Standards	BCRC; VTRANS	2020 to 2025 (ongoing)	Town highway fund; State of VT AOT; FEMA HMGP, PDM, FMA	High
Winter storms	Education and Outreach	Provide educational materials on sheltering in place and preparation for winter storms, including long-term power outages	Town Emergency Management Director	2020 to 2021	Town general fund	High
Winter storms	Education and Awareness	Provide materials for residents on methods to protect property from wind events	Town Emergency Management Director; Zoning Administrator	2020 to 2022	Town general fund; FEMA HMGP, PDM, FMA	High
Winter storms	Local Planning and Regulations	Develop agreements with adjacent towns for sharing of highway equipment	Town Supervisor; VTRANS	2020 to 2021	Town general fund	High

Table 23. Mitigation Actions. Type is based on categories from the Federal Emergency Management Agency 2013b						
Hazard	Type	Action	Responsible Party	Time Frame	Funding Source(s)	Priority
High wind events	Education and Outreach	Provide educational materials on sheltering in place and preparation for winter storms, including long-term power outages	Town Emergency Management Director	2020 to 2021	Town general fund	High
High wind events	Local Planning and Regulation	Require boats, propane tanks and other items stored outdoors to be secured	Town Planning Commission; Zoning Administrator	2020 to 2021	Town general fund	High
High wind events	Local Planning and Regulation	Encourage appropriate plantings to avoid future damage from downed trees	Town Planning Commission	2020 to 2022	Town general fund	Medium
High wind events	Local Planning and Regulation	Encourage protection and planting of wind breaks in new developments	Town Emergency Management Director; Zoning Administrator	2020 to 2022	Town general fund	Medium
High wind events	Structure and Infrastructure Projects	Retrofit existing buildings to withstand high winds including protection of power lines and other utilities	Town Supervisor; Private Owners	2020 to 2025 (ongoing)	FEMA HMGP, PDM	Medium
Hail	Structure and Infrastructure Projects	Retrofit existing buildings to minimize hail damage	Private Owners	2020 to 2022	FEMA HMGP, PDM	Low to Medium
Drought	Local Planning and Regulation	Monitor drought conditions	Town Emergency Management Director	2020 to 2025 (ongoing)	Town general fund	Medium
Drought	Education and Awareness	Provide educational materials on dealing with drought	Town Emergency Management Director	2020 to 2022	Town general fund; FEMA HMGP, PDM	Medium

Table 23. Mitigation Actions. Type is based on categories from the Federal Emergency Management Agency 2013b						
Hazard	Type	Action	Responsible Party	Time Frame	Funding Source(s)	Priority
Drought	Natural System Protection	Develop improved assessment of groundwater sources and amend bylaws to assure their protection	Vermont Geological Survey Town Planning Commission	2020 to 2022	FEMA HMGP, PDM; State of VT	Medium
Hazardous materials spill	Local Planning and Regulation	Update 2012 assessment of hazardous materials and potential accident locations	LEPC 7	2021 to 2022	State of VT; DEC funds	High
Hazardous materials spill	Natural Systems Protection	Identify groundwater source areas and develop ordinances to protect those areas	Vermont Geological Survey; BCRC	2020 to 2022	VT Geological Survey funds	Medium
Infectious disease outbreak	Local Planning and Regulations	Monitor disease occurrences and potential outbreaks, partnering with the VT Dept. of Health	Town Emergency Management Director	2020 to 2025 (ongoing)	VT Dept. of Health	High
Infectious disease outbreak	Education and Outreach	Provide educational materials in printed form on potential infectious diseases	Emergency Management Director	2020 to 2023	Town general fund; VT Dept. of Health	High
Invasive species	Local Planning and Regulations	Monitor extent of invasive species, particularly forest invasive species such as Emerald Ash Borer	BCRC; Bennington County Conservation District	2020 to 2025 (ongoing)	Town general fund	Medium
Invasive species	Local Planning and Regulations	Complete surveys for ash trees vulnerable to Emerald Ash Borer in town highway ROW	BCRC; Bennington County Conservation District	2020 to 2022	FEMA HMGP, PDM; VT Dept. of Forests, Parks and Recreation	Medium

Table 23. Mitigation Actions. Type is based on categories from the Federal Emergency Management Agency 2013b						
Hazard	Type	Action	Responsible Party	Time Frame	Funding Source(s)	Priority
Invasive species	Local Planning and Regulations	Survey for invasive species (e.g., Japanese knotweed) along streams to identify potential erosion areas	Batten Kill Watershed Alliance; Bennington County Conservation District	2020 to 2022	VT Dept. of Forest, Parks and Recreation	Medium
Invasive species	Education and Awareness	Provide outreach materials for landowners on using native plants and controlling invasive species	Bennington County Conservation District	2020 to 2022	Town general fund/VT Dept. of Forest, Parks and Recreation	High

VII. Plan Maintenance

A. Annual Monitoring and Continued Public Involvement

Copies of this plan will be kept at the Bennington County Clerk's office, Shaftsbury Town Hall and made available via the BCRC website. The Town Supervisor intends to involve the public in the implementation, review and update of this plan. Tracking of actions will take place during the annual budgeting process, when funds are allocated for various programs to operate the town, including capital improvements. The Town Supervisor is responsible for developing a town budget and oversees operations in the town.

During the Town Plan update process in 2020, the planning commission will review this plan and incorporate relevant mitigation actions and goals into the Town Plan. New data from a variety of studies completed by the Bennington County Regional Commission, the State of Vermont, the U.S. Forest Service and others will be used in updating the Town Plan, as they were used to develop this hazard mitigation plan. The process of updating the Town Plan will incorporate public involvement, agency review and adjacent town review requirements of Vermont statutes.

B. Plan Evaluation and Update

The Glastenbury Supervisor will be responsible for serving as or appointing a planning team for evaluating and updating the plan.

1. Plan Evaluation

The effectiveness of the plan will be determined by whether or not actions listed in Table 23 are implemented and whether the goals of the plan are being achieved.

a) Annually the Emergency Management Director will review each of the actions in Table 23 to determine their status. Status categories will include completed, in progress, scheduled, no progress.
b) The evaluation will be presented to the Town Supervisor and Planning Commission at a public meeting to allow for a discussion on progress in implementing the plan and the need for applying for funding or to address program and budgeting priorities.
c) The evaluation will be used to update and identify potential changes to town plans, programs and policies.

If requested, the Bennington County Regional Commission will provide advice and assistance on the plan evaluation.

2. Plan Update

At least one year before the five-year period covered by this plan, the planning team will initiate a review of the plan by:

a. Updating the descriptions and analyses of events using new information since completion of this 2018 hazard mitigation plan.
b. Identification of any new buildings or infrastructure or changes in critical facilities.
c. Estimation of potential probability and extent of hazards based on any new information since completion of the 2018 plan and the 2015 Town Plan.
d. Review of completed hazard mitigation projects.
e. Identification of new projects given the revised hazard evaluation.
f. Review of any changes in priorities since adoption of the 2018 plan.
g. Revision of the assessment of risks and vulnerability from identified hazards.
h. Development and use of criteria to assess the potential benefits and costs of identified actions for use in prioritizing those actions.
i. Integration of the updated plan into the Glastenbury Town Plan and other plans and programs.

The planning team will hold open meetings to solicit opinions and to identify issues and concerns from members of the public and stakeholders. The planning team and the Glastenbury Town Supervisor will work with the Bennington County Regional Commission (BCRC) and the State Hazard Mitigation Officer (SHMO) to review and update programs, initiatives and projects based on changing local needs and priorities. The BCRC will assist in any necessary coordination and communication with neighboring towns to assure that mitigation actions address regional issues of concern. The revised plan will be submitted for review by the State Hazard Mitigation Officer and FEMA and revised based on their comments. Following approval by FEMA, the Town Supervisor will adopt the completed plan.

C. Post Disaster Review and Revision

Should a declared disaster occur, Glastenbury may undertake special review of this plan and the appropriate updates made. After Action Reports, reviews and debriefings should be integrated into the update process. The plan should also be updated to reflect completion of projects listed in the basin plan, river corridor plan, culvert surveys and other studies.

VIII. References

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B. Map Data Sources

The Vermont Center of Geographic Information provides data on transportation systems, the location of structures (E911), critical facilities, jurisdictional boundaries, and other information. That data was used in all maps. Data from other sources were used in specific maps as noted below.

Map 1. Vermont Center for Geographic Information, http://geodata.vermont.gov
Basemap from ArcGIS Online (ESRI).

Map 2. Vermont Center for Geographic Information, http://geodata.vermont.gov
National Land Cover Data originally from USGS. Basemap from ArcGIS Online (ESRI).

Map 3. Vermont Center for Geographic Information, http://geodata.vermont.gov
Data from the Bennington County Regional Commission
Glastenbury Town Plan 2015
Basemap from ArcGIS Online (ESRI).

Map 4. Vermont Center for Geographic Information, http://geodata.vermont.gov
Basemap from ArcGIS Online (ESRI).

Map 5. Vermont Center for Geographic Information, http://geodata.vermont.gov
FEMA Flood Map Service Center: https://msc.fema.gov/portal/
Basemap from ArcGIS Online (ESRI).

Map 6. Vermont Center for Geographic Information, http://geodata.vermont.gov
LANDFIRE Program, www.landfire.gov
Vermont Forest Resources Plan, http://anrmaps.vermont.gov/websites/sars_data/
Basemap from ArcGIS Online (ESRI).

Map 7. Dale, J. 2015. Landslide potential in Bennington County, Vermont. Report prepared for Majorie Gale, Vermont Geological Survey from Green Mountain College, Poultney, VT.
Basemap from ArcGIS Online (ESRI).

Map 8. Vermont Center for Geographic Information, http://geodata.vermont.gov
Glastenbury Hazard Mitigation Planning Team
BCRC Data
Basemap from ArcGIS Online (ESRI).

C. Personal Communication Sources

Veronica Fialkowski, MPH., Infectious Disease Epidemiologist, Vermont Department of Health, Veronica.Fialkowski@vermont.gov

Richard Heims, NOAA regarding drought indices, richard.heim@noaa.gov

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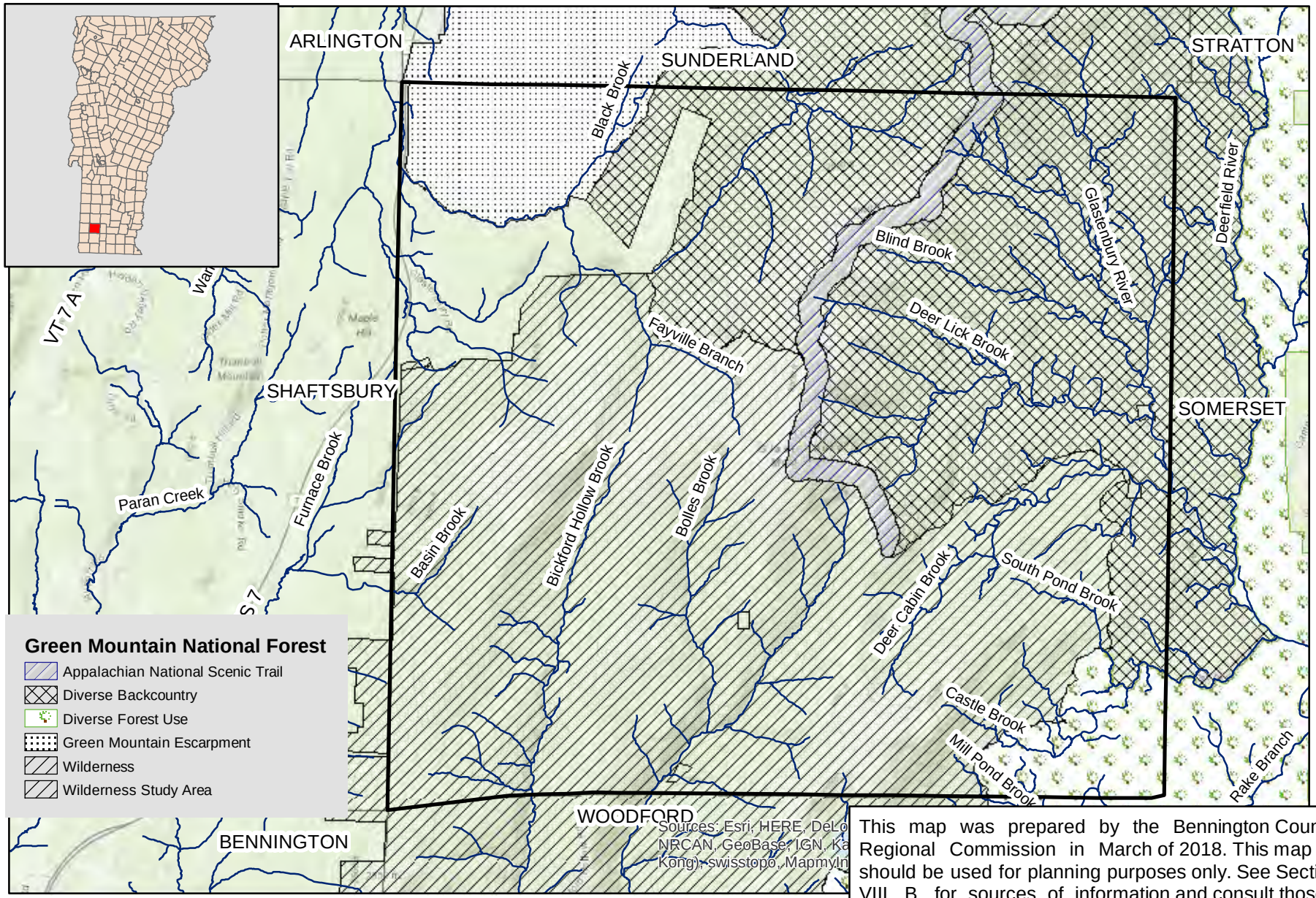
Appendix I. Comments Received

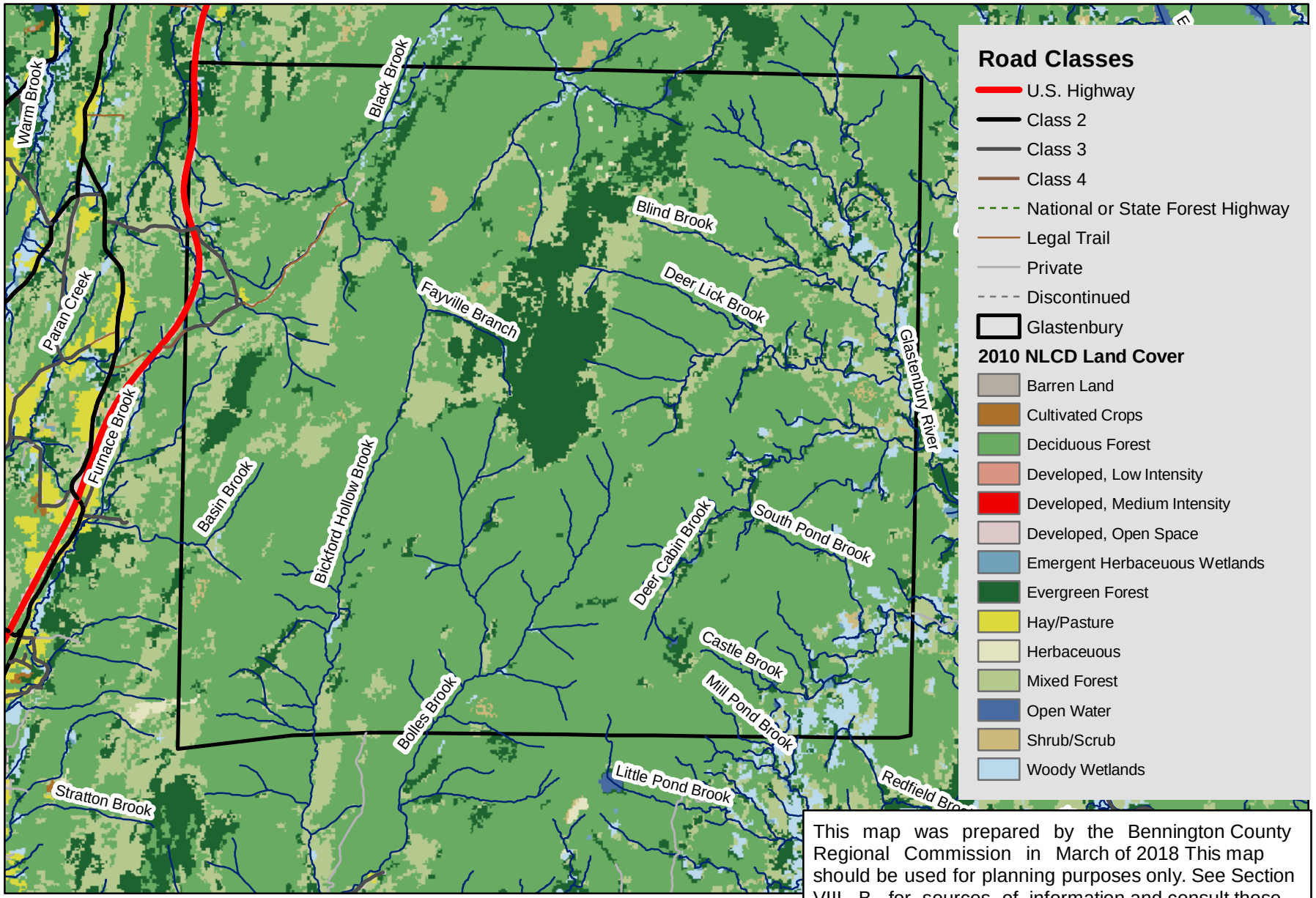
No other comments were received.

Map 1. Town of Glastenbury



This map was prepared by the Bennington County Regional Commission in March of 2018. This map should be used for planning purposes only. See Section VIII. B. for sources of information and consult those sources for data use limitation.

Map 2. Town of Glastenbury Land Cover



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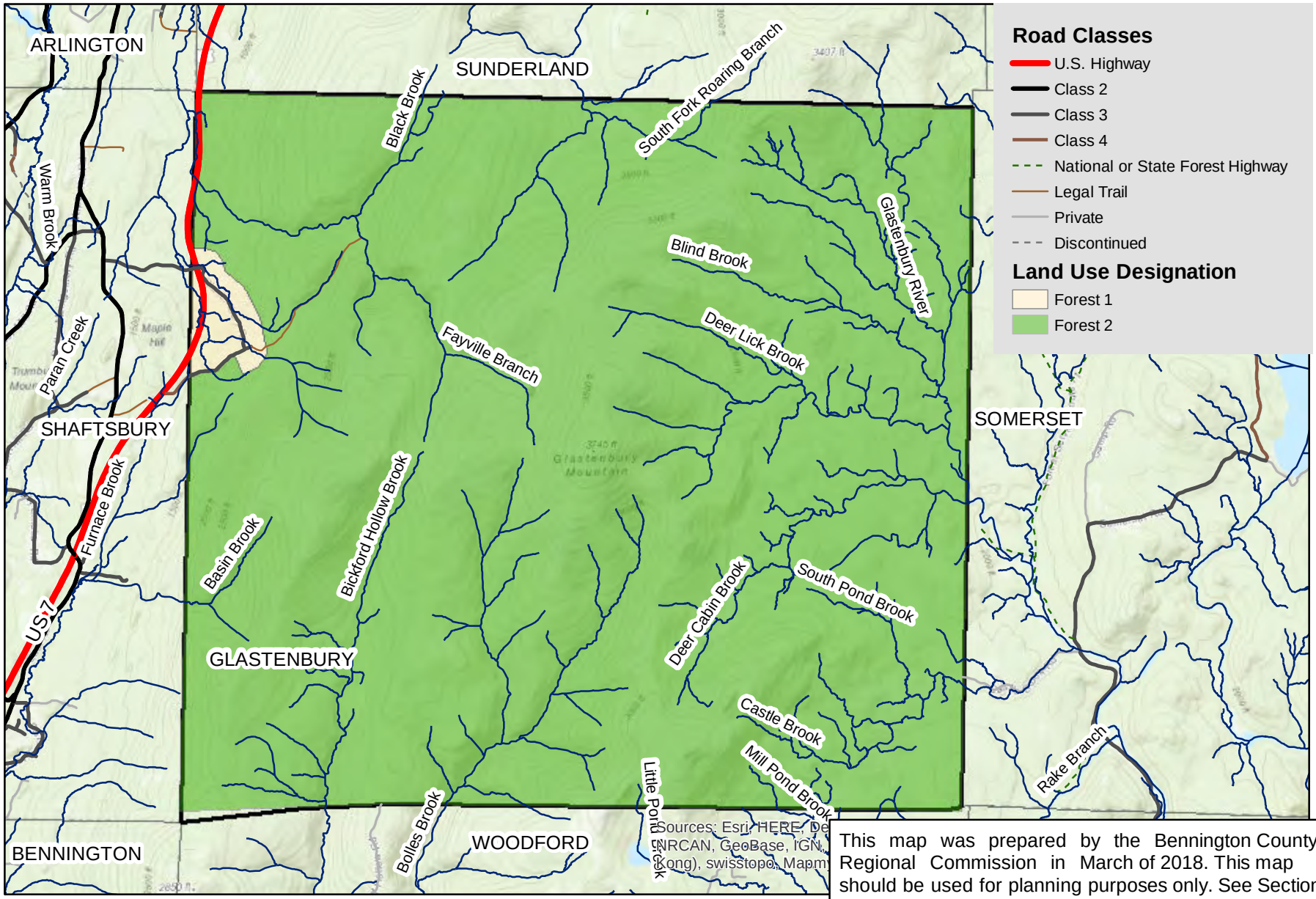
Map 3. Town of Glastenbury Land Use Designations



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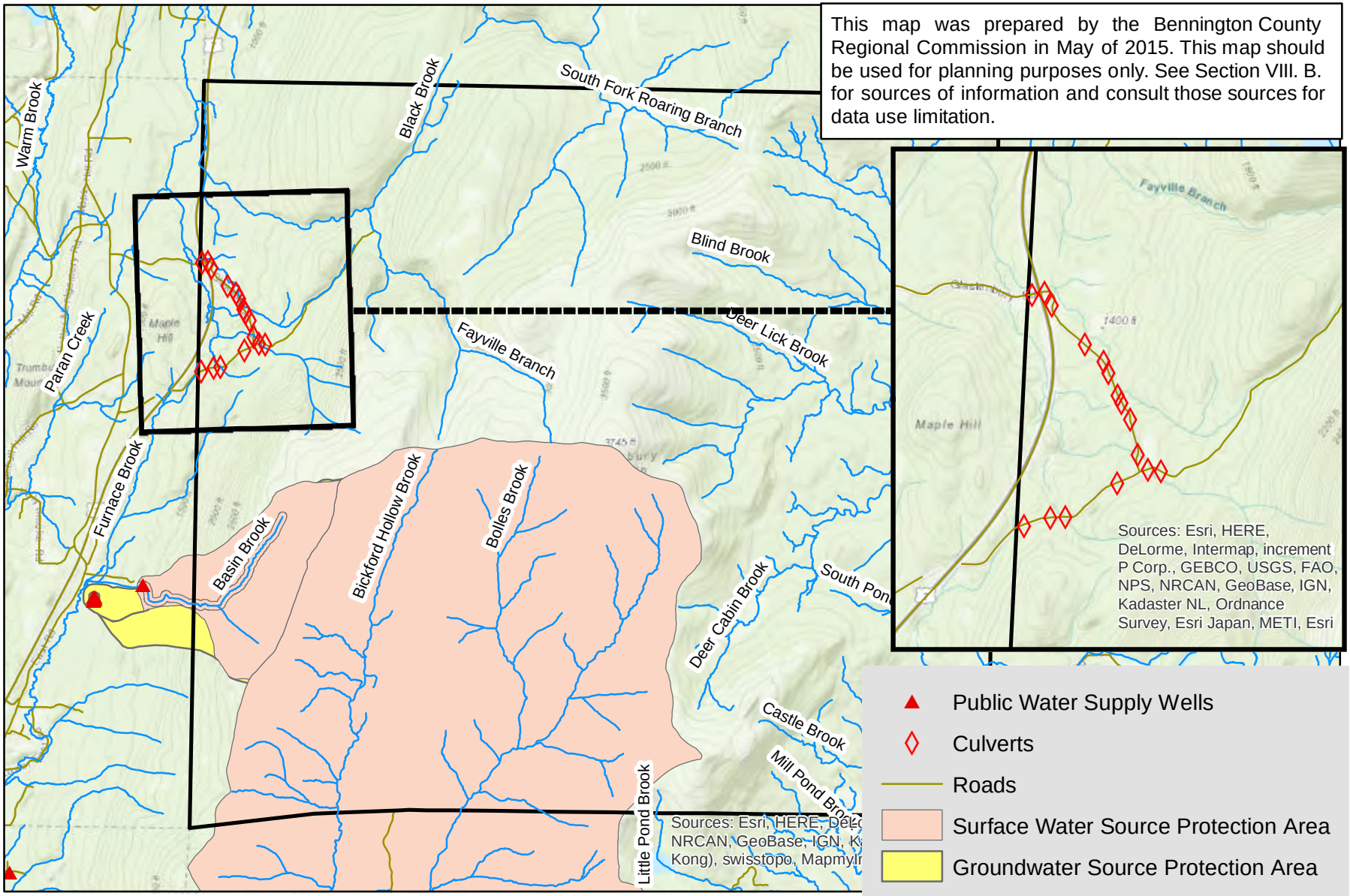
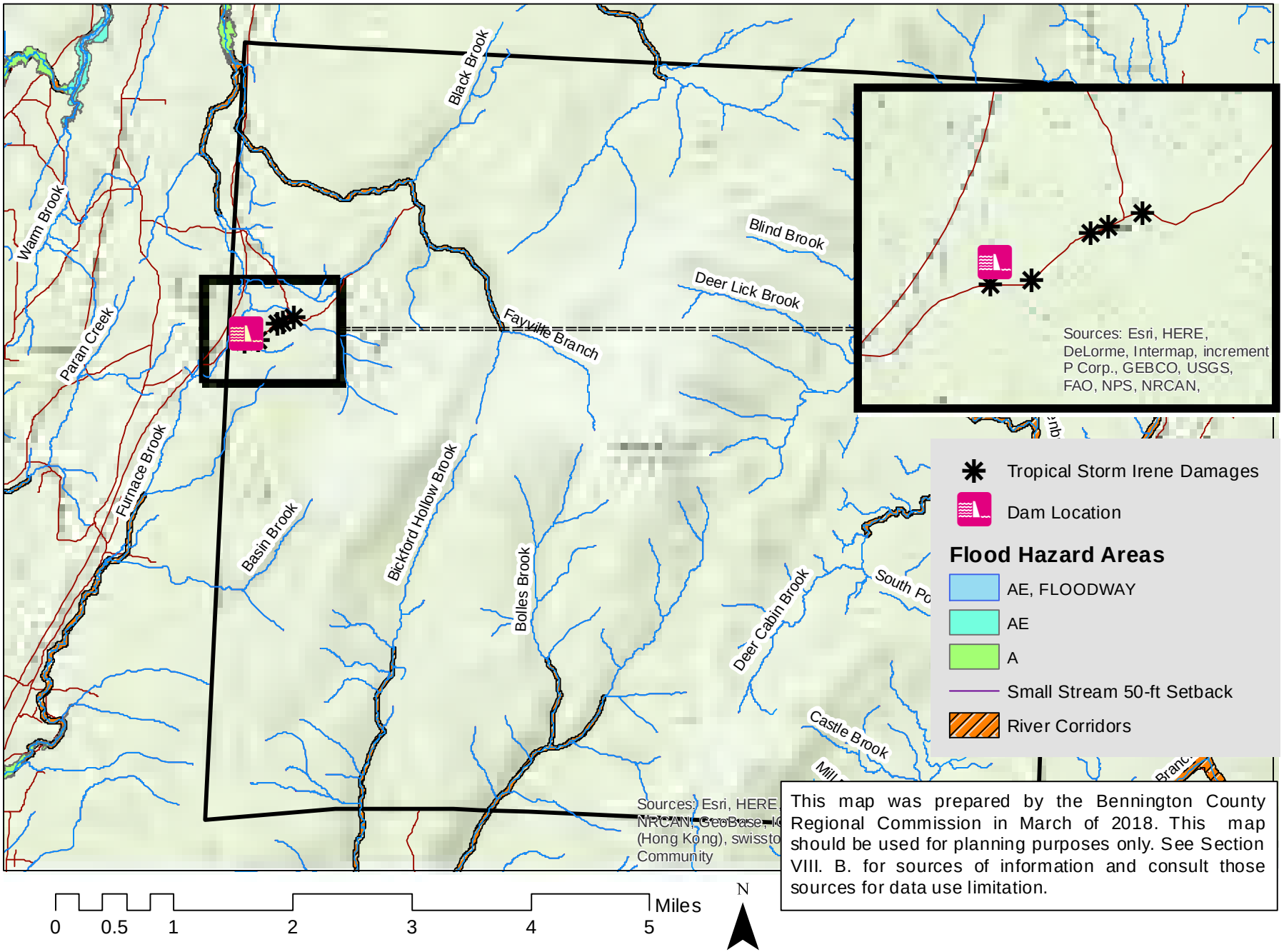
Map 4. Town of Glastenbury Critical Facilities



Map 5. Town of Glastenbury Flood Hazard Zones



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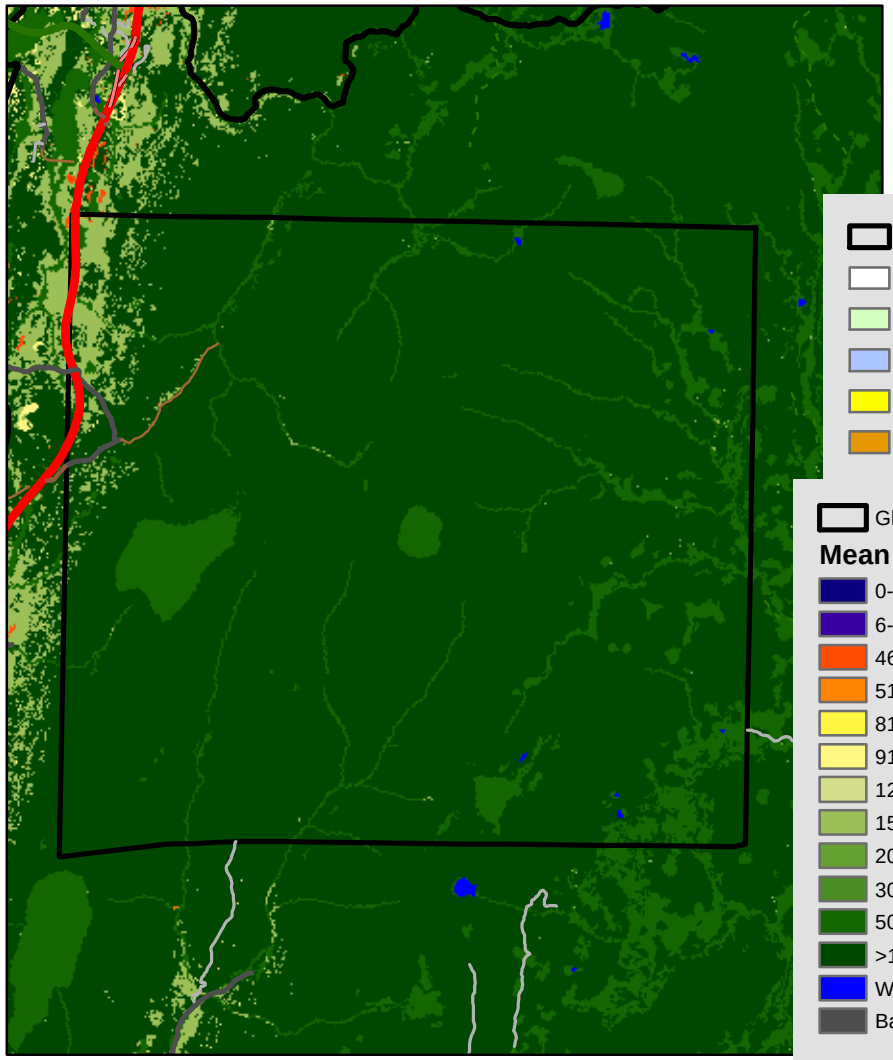
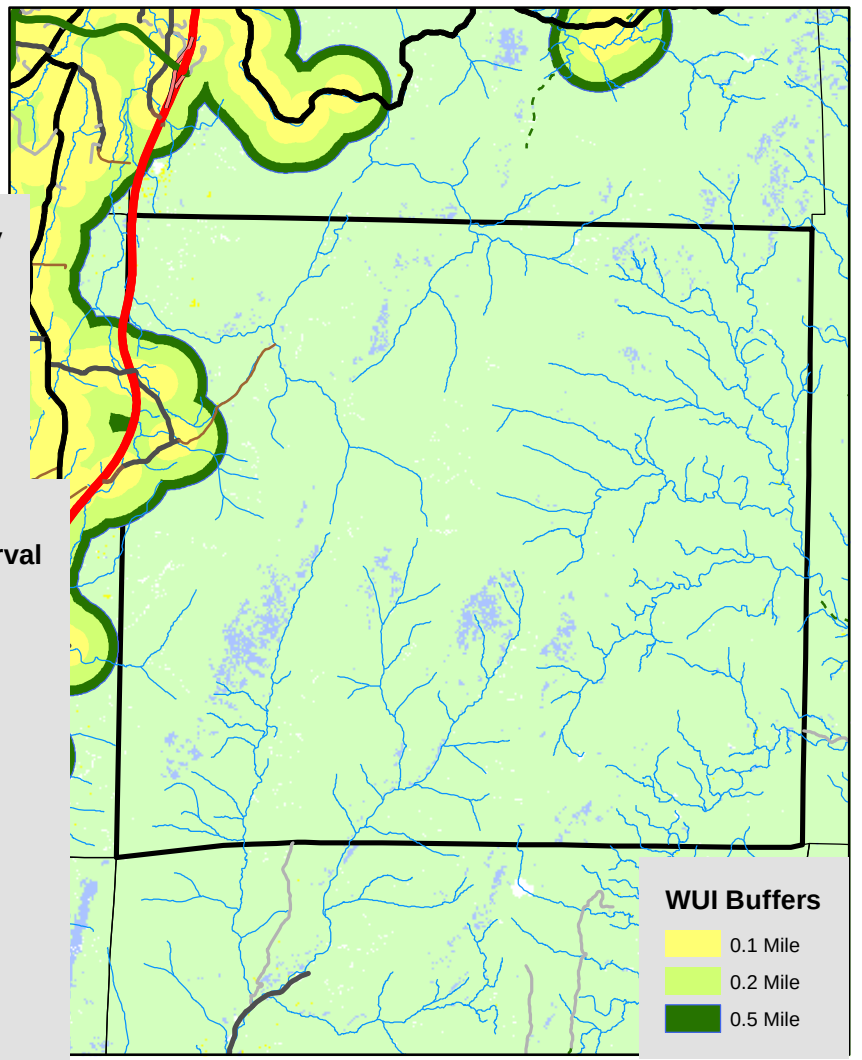
Map 6. Town of Glastenbury Wildfire Potential

Mean Fire Return Interval



Wildfire Risk



Glastenbury
No risk
Low
Moderate
High
Very high

Glastenbury

Mean Return Interval

0-5 Years
6-10 Years
46-50 Years
51-60 Years
81-90 Years
91-100 Years
126-150 Years
151-200 Years
201-300 Years
301-500 Years
501-1000 Years
>1000 Years
Water
Barren

WUI Buffers

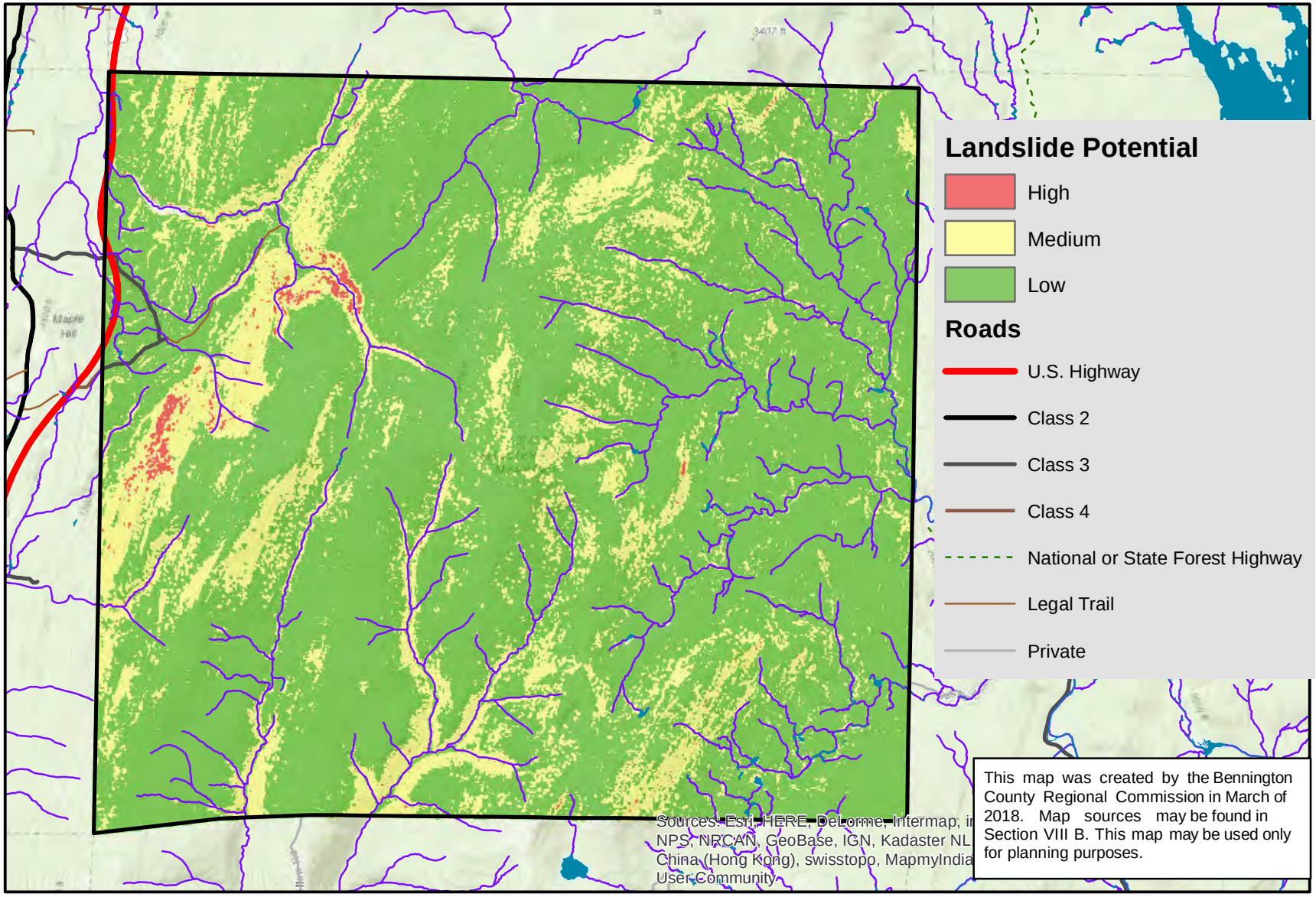
0.1 Mile
0.2 Mile
0.5 Mile

N

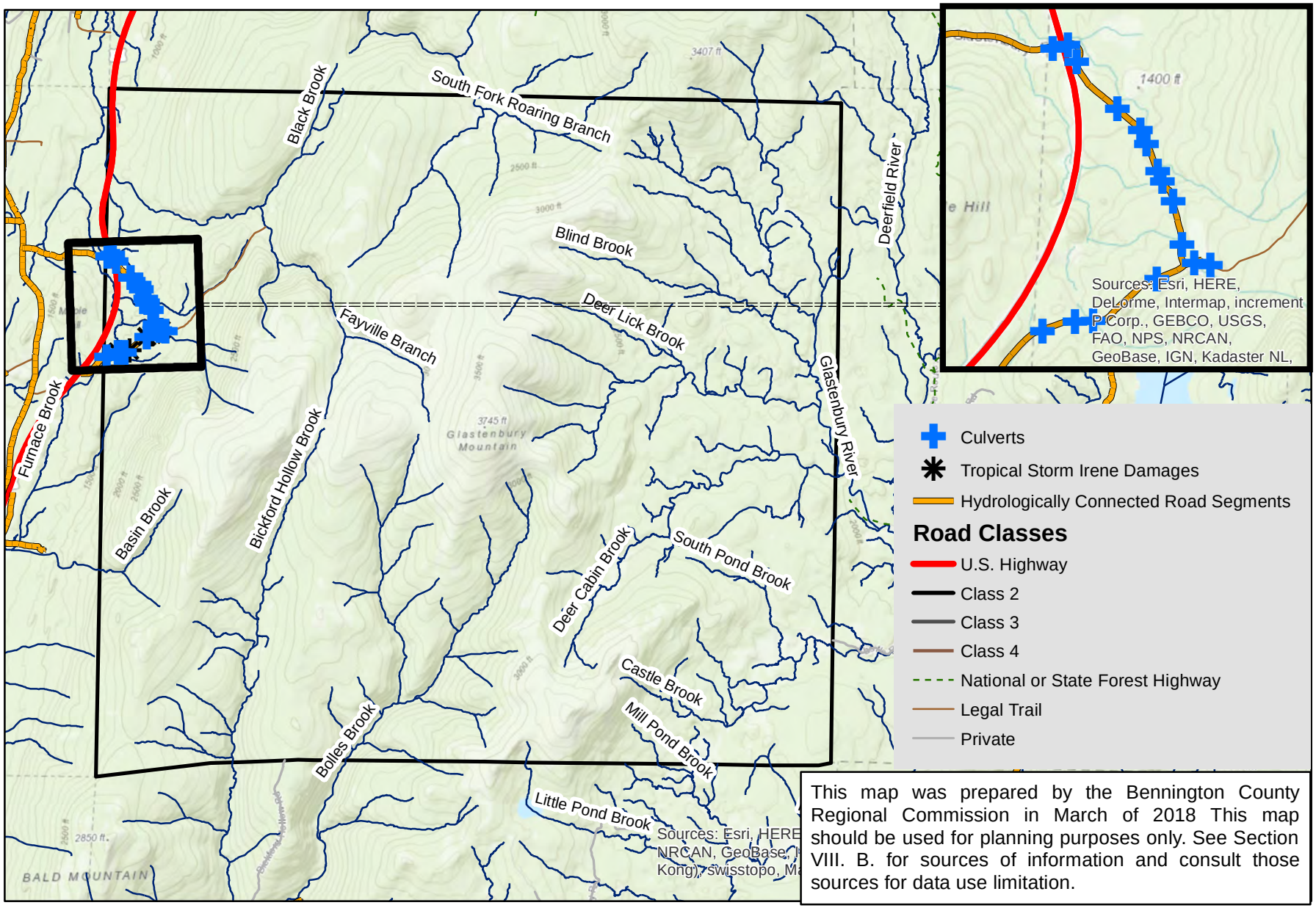
0 1.25 2.5 5 7.5 10 Miles

This map was created by the Bennington County Regional Commission in March of 2018. Map sources may be found in Section VIII B. This map may be used only for planning purposes.

Map 7. Town of Glastenbury Landslide Potential



Map 8. Town of Glastenbury Vulnerable Areas



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