

# Chapter Eight: Flood Resilience

## I. INTRODUCTION

This chapter of the regional plan describes the hydrological setting of the region, identifies general areas subject to flooding and fluvial erosion and factors that can exacerbate flood damage; identifies data sources that municipalities can use in the preparation of local flood resilience plans; and provides recommendations on strategies to mitigate the risks to public safety, critical infrastructure, historic structures and public investments.

In general, any new development should occur outside of identified flood hazard, and fluvial erosion hazard areas. If new development is built in such areas, it should be done in such a way as to not exacerbate flooding and fluvial erosion. In addition to avoiding development in flood hazard areas, attention should be given to the protection and restoration of floodplains and upland forested areas that attenuate and moderate flooding and fluvial erosion. Finally, emergency preparedness and response planning will save lives and promote resilience in the face of flood events.

## II. EXISTING CONDITIONS:

### **Watershed**

A watershed is a geographic area in which all water flows into a single river. There are seven large watersheds (basins) that extend across the region. The delineation of watersheds follows the topography, so does not respect political boundaries. The Northeast Kingdom region shares watersheds with counties in Vermont to the south and west, with Canada to the north and New Hampshire to the east.

The seven drainage basins in the region are: Basin 6, the Missisquoi; Basin 7, the Lamoille; Basin 8, the Winooski; Basin 14, which includes the Stevens, Wells, Waits and Ompompanoosuc subwatersheds; Basin 15, the Passumpsic; Basin 16, which includes the Upper Connecticut, Nulhagan, Willard Stream, and Paul Stream subwatersheds; and Basin 17, which includes the Lake Memphremagog, Coaticook & Tomifobia subwatersheds. (see Figure 8.1)

### **Topography, soils and wetlands**

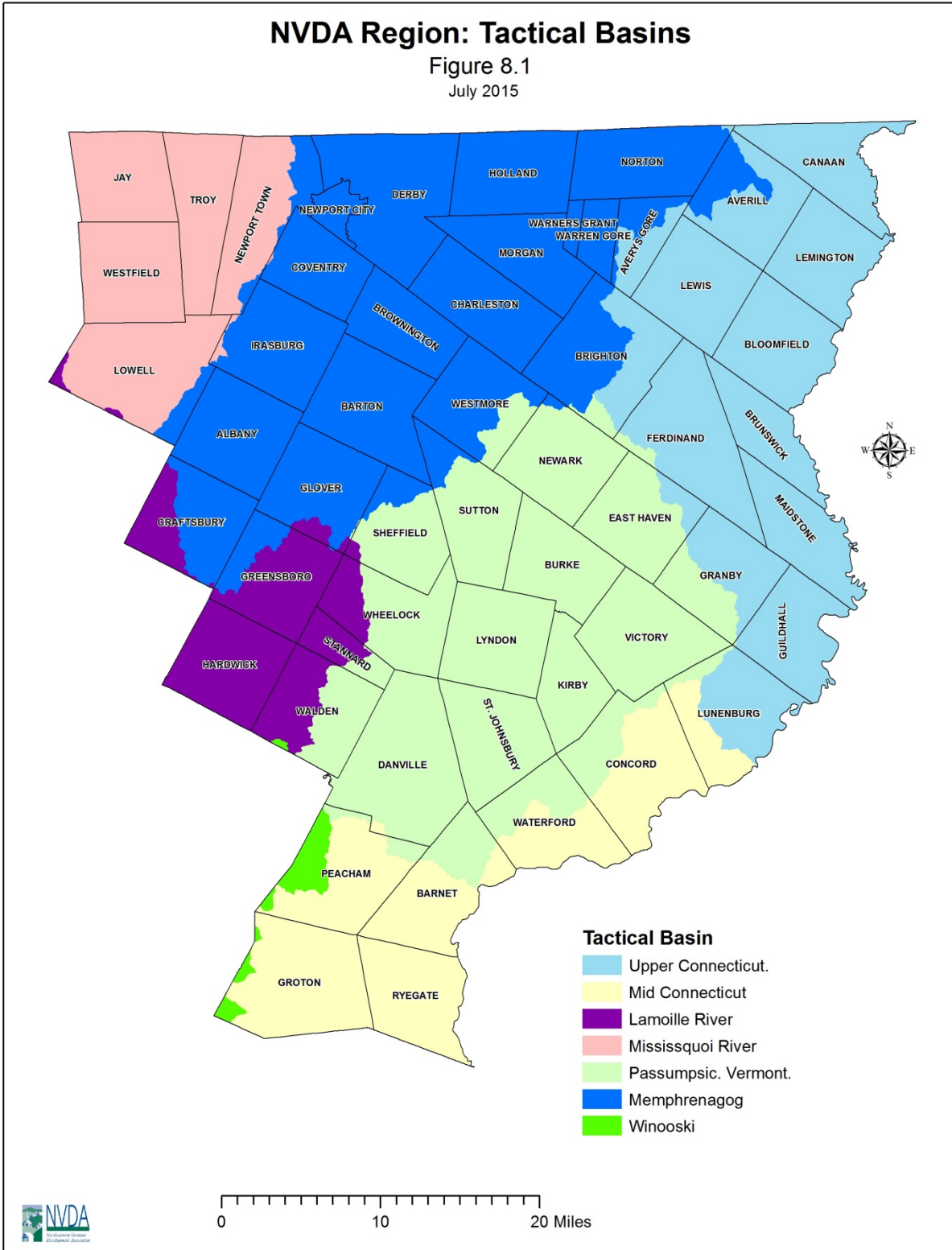
Topography and soils factor into how susceptible an area is to erosion hazards. Areas of steep slopes with shallow soils are susceptible to erosion, particularly if cleared of natural vegetation.

Figures 8.2 through 8.4 depict the distribution of soils classified by different degrees of erodibility throughout the region. The soil erodibility classification system was developed by the Natural Resources Conservation Service (NRCS). In general, soils with greater permeability, higher levels of organic matter and improved soil structure have a greater resistance to erosion. Soils that contain silt, very fine sand and expansive clays (having a high shrink-swell capacity) tend to have increased susceptibility to erosion.

# NVDA Region: Tactical Basins

Figure 8.1

July 2015



- 1
- 2 Wetlands provide a variety of beneficial functions, including mitigation of risk of flood damage. The location
- 3 of mapped wetlands are depicted on figures 8.2 through 8.4.

1 Wetlands have the capacity to store stormwater during high runoff events. When located in a floodplain,  
2 wetlands can store flood waters that overflow riverbanks. As flood waters recede, the water is released slowly  
3 from the wetland soils. By slowing the rate that water re-enters the stream channel, wetlands can reduce the  
4 severity of downstream flooding and erosion. The Vermont Watershed Management Division reports that in  
5 watersheds where wetlands have been lost, flood peaks may increase by as much as 80 percent.

6 Vegetated wetlands along river and streambanks can protect against erosion caused by fast-moving waters  
7 during floods and storms. Wetland plants serve to absorb the energy of the current and bind soil and  
8 deposited sediments in their dense root systems.

9 Additional values of wetlands, including their role in providing plant and wildlife habitat and maintaining  
10 water quality, are discussed in the Natural Resources section of this plan.

## 11 **Identified Flood Hazard Areas**

12 In Vermont, there are two primary means of identifying areas subject to flood hazard: the areas mapped by  
13 the Federal Emergency Management Agency (FEMA) as areas of special flood hazard; and areas mapped by  
14 the State of Vermont Department of Environmental Conservation known as the State-wide River Corridors.  
15 The FEMA maps primarily identify areas of inundation (rising floodwaters), while the River Corridors  
16 identify areas subject to fluvial erosion hazards (when fast moving water in a river or stream erodes the  
17 streambank and adjacent land). The State-Wide River Corridors in Caledonia, Essex and Orleans counties are  
18 depicted on figures 8.2 through 8.4

19 The FEMA maps are known as the Flood Insurance Rate Maps (FIRM) because of their use in the National  
20 Flood Insurance Program (NFIP). The flood hazard and risk information presented on the FIRMs is the  
21 result of engineering studies that are approved by FEMA. The Special Flood Hazard Area shown on a FIRM  
22 is the area that has a 1-percent or greater chance of flooding in any given year; this area is also referred to as  
23 the 1-percent-annual-chance floodplain, base floodplain or the 100-year floodplain.

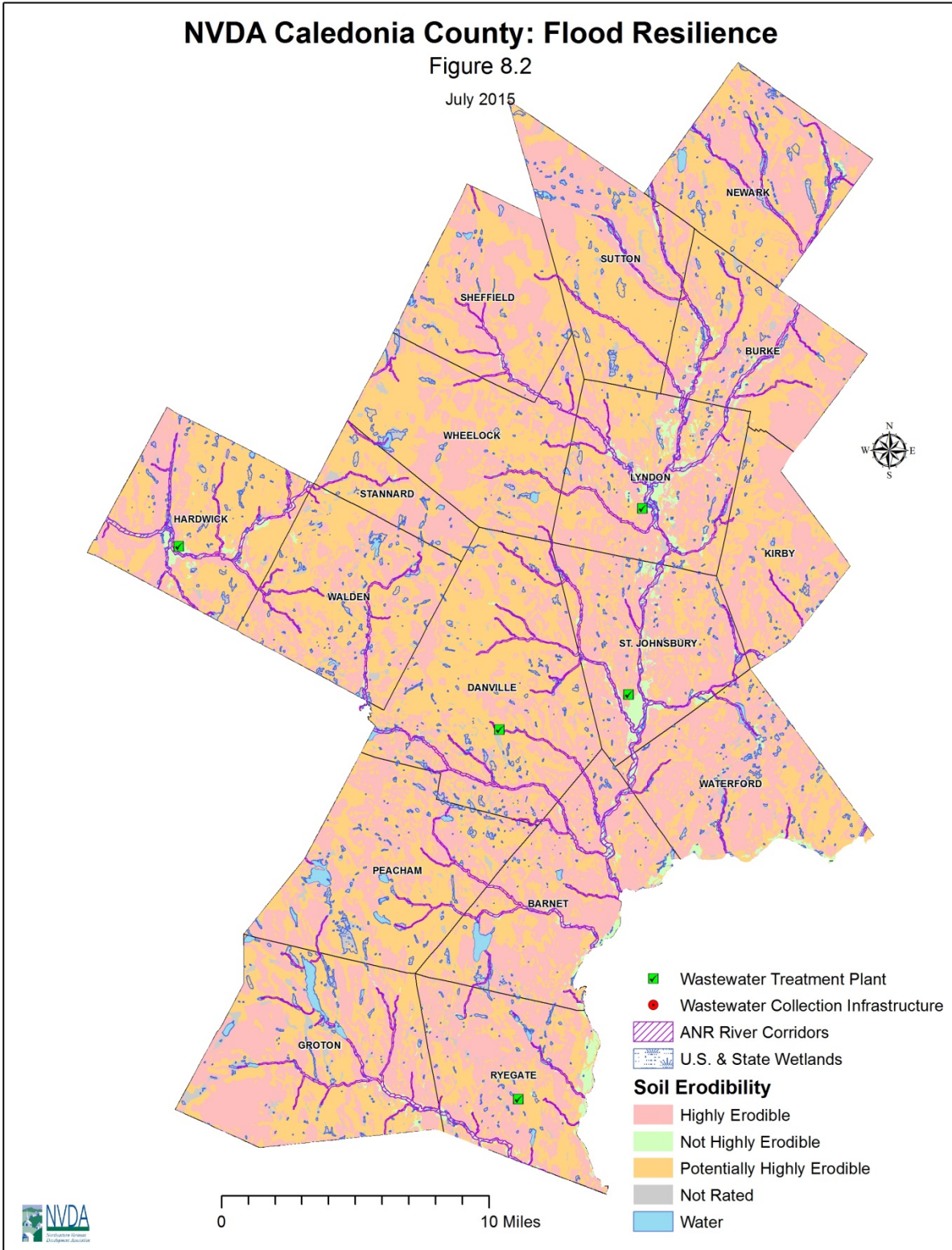
24 In the Northeast Kingdom region, most of the FIRM maps are over 30 years old. Only two municipalities in  
25 the region currently have up-to-date, FEMA maps: Jay and Hardwick. These digitized maps (known as D-  
26 FIRMs) have a much higher level of accuracy than the older maps because the flood hazard information is in  
27 a GIS format that can be easily integrated with other local GIS data layers. This allows more clear  
28 identification of land areas and existing development that is within the flood hazard area. Although the older  
29 FIRM maps lack this level of accuracy, they have been scanned and are available for viewing online at the  
30 FEMA map Center site: <https://msc.fema.gov/portal>.

31 Because of errors on the FIRMs that are due to scale or inaccuracies on the source maps, FEMA has an  
32 administrative procedure to change the designation of properties on the FIRM. These

# NVDA Caledonia County: Flood Resilience

Figure 8.2

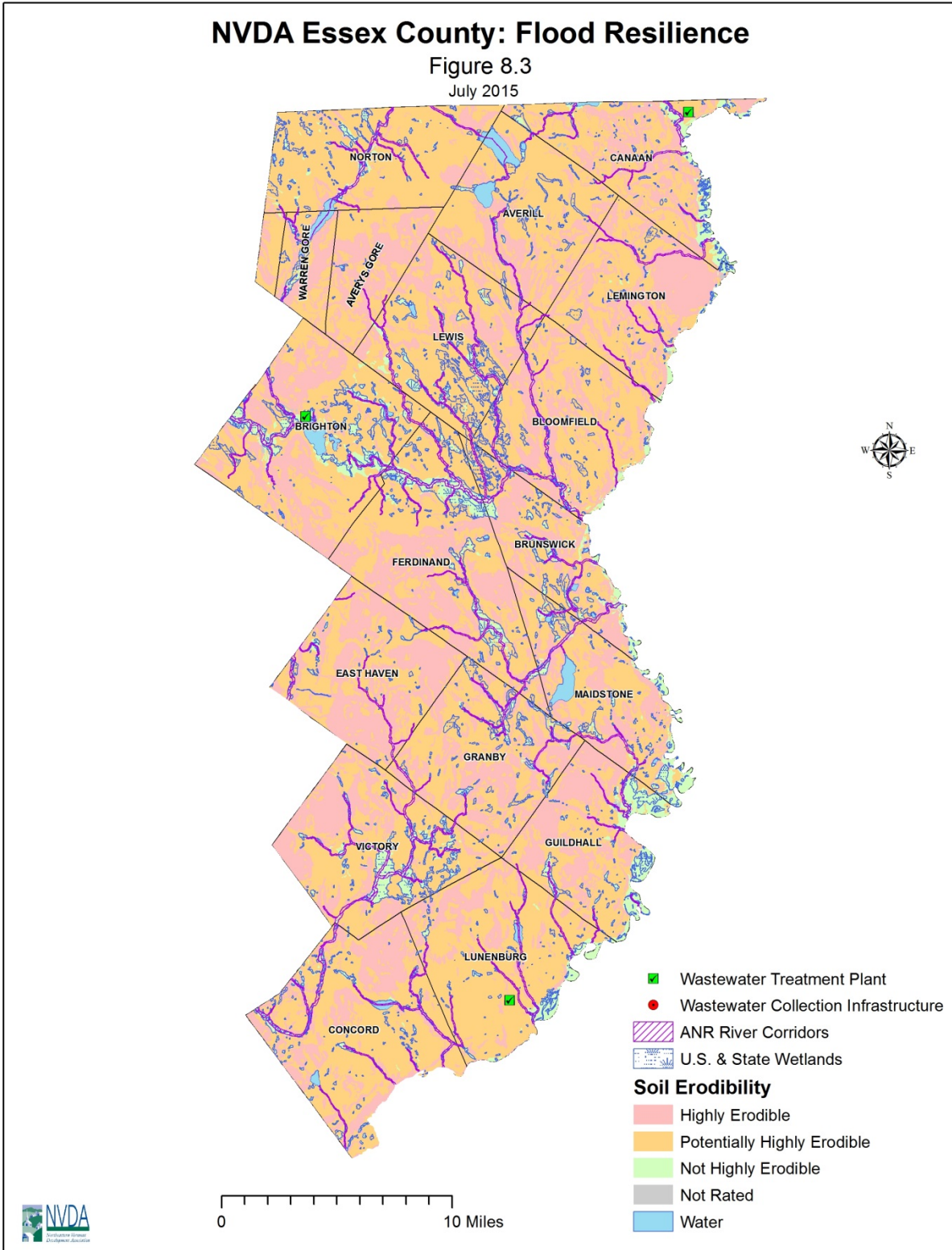
July 2015



# NVDA Essex County: Flood Resilience

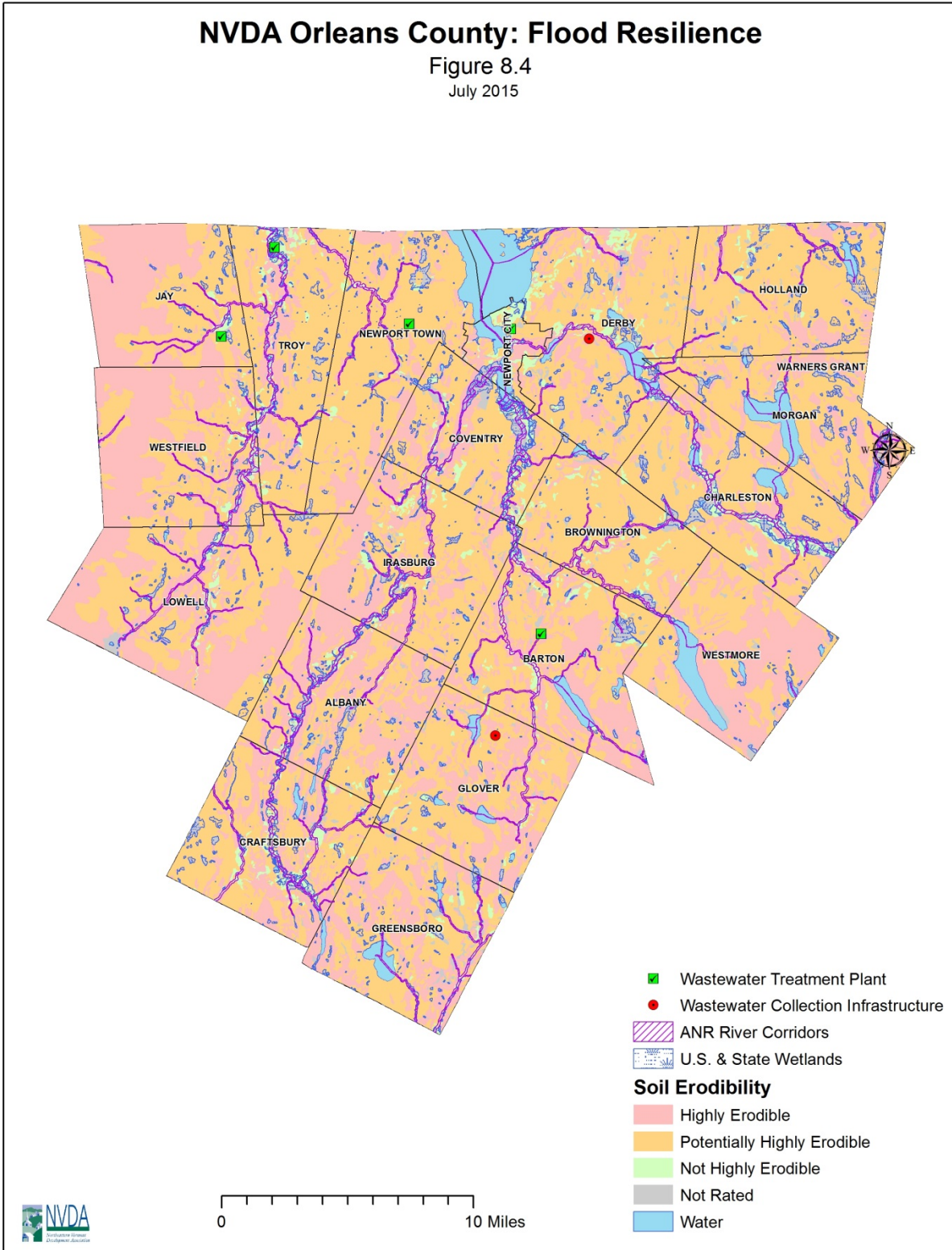
Figure 8.3

July 2015



# NVDA Orleans County: Flood Resilience

Figure 8.4  
July 2015



1  
2 processes are referred to as the Letter of Map Amendment (LOMA) process, and the Letter of Map Revision  
3 Based on Fill (LOMR-F) process. Through these processes, an individual who owns, rents or leases property

1 may submit mapping and survey information to FEMA and request that FEMA issue a document that  
2 officially removes a property and/or structure from the Special Flood Hazard Area. In most cases, the  
3 applicant will need to hire a licensed land surveyor or Professional Engineer to prepare an “Elevation  
4 Certificate” for the property.

5 Membership in the NFIP is done at the municipal level. Membership allows residents of the town to secure  
6 flood insurance if they are within the FEMA-mapped flood hazard area, and affords residents outside the  
7 mapped flood hazard area a better rate on flood insurance. If a Town wishes to be a member of the NFIP,  
8 the town must agree to regulate the development of land within the areas of special flood hazard, as shown  
9 on the FIRM, to minimum standards established by FEMA.

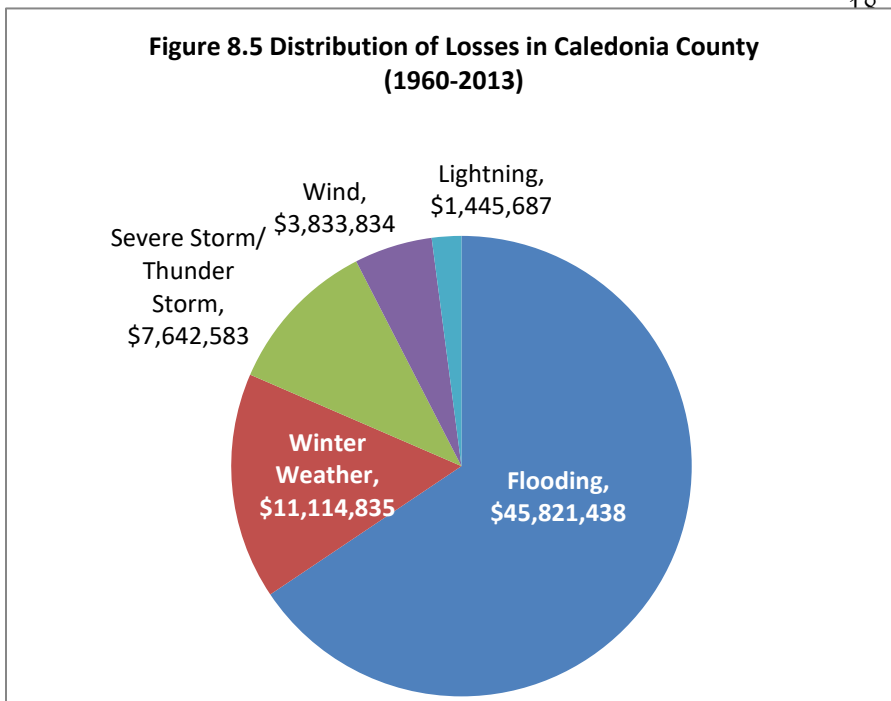
10 It is noted that not every town in the region has FIRMs, even if they are susceptible to flooding. This is true  
11 for some towns that have had historically low populations and structures in areas prone to flooding.  
12 However, this does not mean that those communities are not subject to flood hazards.

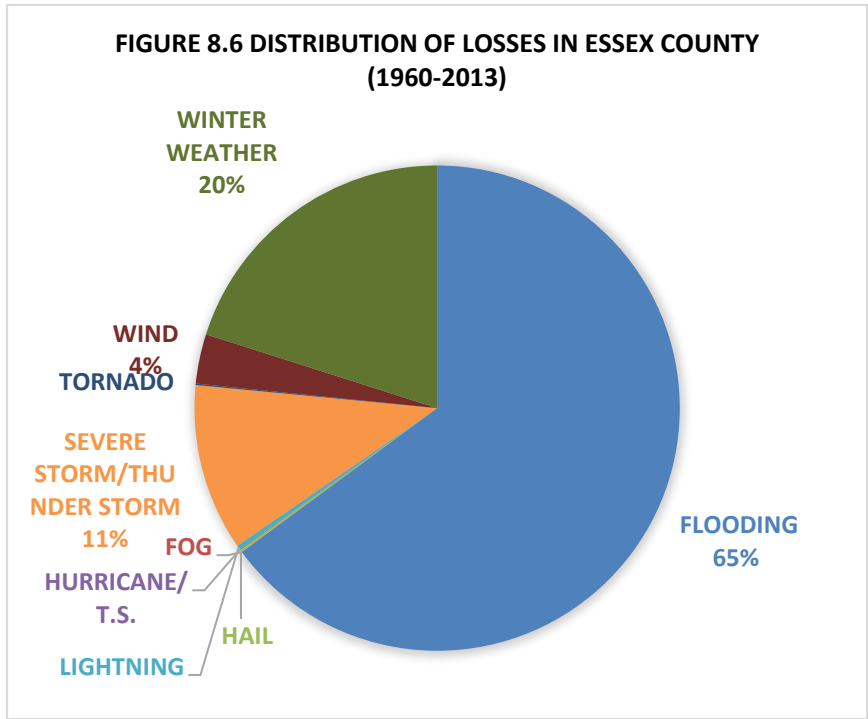
### 13 Structures in Flood Hazard Areas

14 For the reasons noted above, getting an accurate count of structures within the FEMA-mapped flood hazard  
15 area is difficult. Moreover, such a count does not necessarily predict the risk of flood damage within a  
16 community, since FEMA’s mapping is elevation-based and does not consider fluvial erosion factors. A  
17 structure on a highly elevated river bank could get washed away due to erosive action of the stream course,

but not be identified as at-risk under FEMA’s methodology.

For this reason, towns are advised to identify structures both in the FEMA-mapped flood hazard area and the mapped State-wide River Corridors when preparing a local flood resilience plan. Also, since the State-wide River Corridors are provided in standard GIS format, they have a much higher level of accuracy than the older FIRMS.





**Trends in Flood Damage.**

FEMA provides data on the number of projects and cost for repairing damage due to a variety of disaster events.

A database known as SHELDUS (Spatial Hazard Events and Losses Database for the US) provides data on disaster events by county. In the Northeast Kingdom region (as in the rest of the State) damage due to flooding has been the most costly.

20 **RESOURCES**

21 There are a number of reports and sites that provide detailed information on the conditions within the region's  
 22 watersheds, and provide guidance on specific projects that can serve to mitigate future damage due to  
 23 flooding and fluvial erosion.

24 **Tactical Basin Plans**

25 The Watershed Management Division of the Department of Environmental Conservation (DEC) within the  
 26 Vermont Agency of Natural Resources (ANR) undertakes assessments and provides guidance on issues  
 27 related to both water quality and flood resilience. Flooding and fluvial erosion not only cause damage to  
 28 buildings and road infrastructure, but can adversely affect water quality. Likewise, mitigation measures that  
 29 are undertaken to improve water quality can also serve to mitigate flood hazards.

30 The Watershed Management Division produces Tactical Basin Plans to manage surface waters in each of the  
 31 State's 17 basins (see Figure 8.1). The tactical plans include monitoring and assessment data, and the  
 32 protection and restoration tools pertaining to rivers, lakes, wetlands and stormwater. Each plan prioritizes  
 33 projects for funding within the watershed, and integrates priority items from complementary plans, including  
 34 River Corridor Plans, Stormwater Master Plans, Backroads Inventories, and Agricultural Environmental  
 35 Assessments.

36 Although the main focus of the Tactical Basin Plans is water quality, these plans are a good place to start  
 37 when a municipality begins to develop a flood resilience section as part of their Town Plan, since they  
 38 incorporate a host of studies pertaining to surface water management. Tactical Basin plans can be found on  
 39 the Watershed Management Division site here: <http://www.watershedmanagement.vt.gov/planning.htm>.

40 As previously noted, the basins follow hydrological boundaries rather than political boundaries, so each  
 41 Tactical Basin Plan produced by the Watershed Management Division covers a number of municipalities that  
 42 may lie in different counties. Basin Plans pertaining to the Northeast Kingdom region are as follows:

- 43 • *Missisquoi Bay Basin Water Quality Management Plan, (Basin 6)* Approved March 2013.
- 44 Covering the towns of Jay, Westfield, Troy and portions of Irasburg, Newport Town, and Lowell.



- 1
- 2 • *Lamoille River Basin Water Quality Management Plan, (Basin 7)* Draft, February 2009.
- 3 Covering the town of Hardwick and portions of the towns of Craftsbury, Glover, Greensboro,
- 4 Stannard, Walden and Wheelock.
- 5 • *Winooski River Basin Water Quality Management Plan, (Basin 8)* Approved May 2012.
- 6 Covering portions of Groton, Peacham and Walden.
- 7 • *Basin 14 Tactical Basin Plan-2015, including the Stevens River, Wells River, Waits River,*
- 8 *Ompompanoosuc River, and Mid-Connecticut River Direct Tributaries Watersheds,* Draft,
- 9 June 2015. Covering the town of Ryegate and portions of Barnet, Danville, Groton, and Peacham.
- 10 • *Passumpsic and Upper Connecticut River Tactical Basin Plan, (Basin 15 and Basin 16)*
- 11 Approved June 2014. Covering the towns of Bloomfield, Brunswick, Burke, Canaan, Concord, East
- 12 Haven, Ferdinand, Granby, Guildhall, Kirby, Lemington, Lunenburg, Lyndon, Maidstone, St.
- 13 Johnsbury, Victory, and Waterford; and portions of Averill, Avery’s Gore, Barnet, Brighton,
- 14 Danville, Peacham, Newark, Norton, Sheffield, Stannard, Sutton, Westmore, Wheelock, and Walden.
- 15 • *Basin 17 Water Quality Management Plan,* Approved January 2012. Covering the towns of
- 16 Albany, Barton, Brownington, Charleston, Coventry, Derby, Holland, Morgan, Newport City,
- 17 Warners Grant; and portions of Averill, Avery’s Gore, Brighton, Craftsbury, Greensboro, Glover,
- 18 Irasburg, Newport Town, Newark, Norton, Sheffield, Sutton, Westmore, and Warren Gore.

19 **River Corridor Plans**

20 River Corridor Plans are more detailed studies of streams and rivers within the subwatersheds of the larger  
 21 basins. These plans include an assessment of the natural tendencies of a stream, its current condition, and  
 22 what changes may be anticipated in the future (also known as “stream geomorphic assessments”). The River  
 23 Corridor plans use the results of the assessments to provide both general and site-specific guidance on ways  
 24 to alleviate flood hazards and improve water quality within those areas. Recommended projects can range  
 25 from enlarging culverts to alleviate channel constriction, reducing erosion potential along stream banks by  
 26 revegetation, to reconnecting floodplains to the adjacent river in order to reduce flood risk downstream.  
 27 River Corridor Plans can be found on the Watershed Management Division’s site, here  
 28 <https://anrweb.vt.gov/DEC/SGA/finalReports.aspx>

29 **Natural Resources Atlas**

30 The Natural Resources Atlas at <http://anrmaps.vermont.gov/websites/anra/> contains a “road erosion risk”  
 31 layer, which ranks the erosion risk of unpaved Class 2, 3 and 4 Town roads as well as driveways longer than  
 32 1,000 feet. Features considered in assessing risk include undersized culverts, elevation and slopes, soil types,  
 33 and proximity to rivers, lakes, and wetlands. The result is an identification of road segments that have a  
 34 “low”, “moderate” or “high” erosion risk. This is a useful tool for communities to identify potential road  
 35 hazards during storm events.

36 **Flood Ready Website**

37 The State of Vermont maintains a “Flood Ready” website that acts as a clearinghouse of all information  
 38 related to flood resilience planning. The site contains good examples of local flood resilience plans, mitigation  
 39 measures, identifies funding sources, and provides an overview of the Emergency Relief Assistance Fund  
 40 (ERAF) rules, identifying the measures needed by municipalities to qualify for the highest level of funding  
 41 under this program.

42 **PLANNING CONSIDERATIONS**

43 Guiding new development to areas that are not within flood and fluvial erosion hazard areas is first on the list  
 44 for mitigating future flood loss. Preserving floodplain wetlands to provide area for floodwater storage, and in

1 some cases taking action to reconnect stream course to these floodplains is also a key step that can alleviate  
2 future flood damage. As noted previously, loss of wetlands has been shown to substantially increase flood  
3 risk.

4 For structures that are already within flood hazard areas, there are steps that can be taken to mitigate against  
5 future flood risk. FEMA has published a guide entitled “Protecting Your Home and Property From Flood  
6 Damage, Mitigation Ideas for Reducing Flood Loss.”(October 2010) The guide begins with guidance on how  
7 to go about repairing a flood damaged house, from getting back in safely to selecting a contractor and water-  
8 resistance building materials. The guide also provides a list of mitigation strategies when rebuilding after a  
9 flood, including relocating or elevating the structure, installing floodwalls and foundation drainage systems.

## 10 **Local Land Use Regulations**

11 One of the requirements of membership in the NFIP is that the Town administer flood hazard regulations.  
12 While these regulations address the flood hazard areas identified by FEMA, they do not necessarily address  
13 fluvial erosion hazard areas associated with the movement of rivers and streams. It is recommended that  
14 Towns also consider including the state-mapped river corridors in the areas to be regulated by flood hazard  
15 regulations. Although this is not intended to affect flood insurance requirements of properties with the  
16 designated river corridor, it is a way for towns to better mitigate future flood risk. The Watershed  
17 Management Division of the DEC has prepared model flood hazard regulations that include regulation of  
18 land in river corridors.

19 The provision for Planned Unit Developments in local land use regulations is another way to facilitate  
20 development that reduces the risk of floods. They allow more flexible requirements for developments that  
21 achieve environmental benefits, such as preservation of open space, and minimization of impervious surfaces.

22 Towns may also wish to establish limits on impervious coverage, clearing on areas of steep slopes, and  
23 disturbance to steep slopes as part of their land use regulations. Such measures will mitigate against damage  
24 caused by erosion of steep slopes and excessive stormwater runoff, which can overwhelm drainage  
25 infrastructure during storm events.

26 Of the 33 towns in the Northeast Kingdom region with land use regulations, 19 include a provision for  
27 Planned Unit Developments, 6 include limits on impervious surfaces, and 8 limit disturbance to steep slopes.

## 28 **Infrastructure planning**

29 Planned improvements to road and stormwater infrastructure, including road culverts and bridges, should  
30 take into consideration the priorities and site specific projects identified in the tactical basin plans, and river  
31 corridor plans for the region.

32 New roads to serve residential or commercial development should not occur within flood hazard areas  
33 identified by FEMA, or within fluvial erosion hazard areas as depicted on the State-wide River Corridors, or  
34 as identified in a stream geomorphic assessment report.

35 The State Road and Bridge Standards are based on best management practices to guard against damage to  
36 road infrastructure from erosion and flood damage. Although implementation of the standards on all  
37 roadways in a municipality may have high up-front costs, the long range savings in maintenance and repair to  
38 roadways can result in long-term savings to municipalities.

## 39 **Historic Structures and Critical Facilities**

40 Identification of historic properties and other critical infrastructure, such as public buildings used for shelters,  
41 emergency services buildings, and water and wastewater treatment facilities, will help communities better plan  
42 for emergencies. Such an inventory will help municipalities be in a better position when requesting funding  
43 for mitigation actions, such as flood-proofing or moving a structure to higher ground or outside of a fluvial  
44 erosion zone. (See the historic resources section of this plan for a discussion of resources in the region.)  
45 Because critical facilities are defined by their ability to quickly and efficiently respond to and recover from  
46 floods, critical facilities should never be flooded, and their critical actions should never be conducted in

1 floodplains if at all avoidable. The Association of State Floodplain Managers recommends that where critical  
 2 facilities are located adjacent to special flood hazard areas, their flood protection elevation should be two feet  
 3 above the elevation with a 0.2% chance of flooding (the 500 year floodplain).

4 **ERAF**

5 The Emergency Relief Assistance Fund (ERAF) provides Public Assistance grants through FEMA to help  
 6 Vermont municipalities repair damaged infrastructure after a presidentially-declared disaster. In past years,  
 7 ERAF funding typically covered half the required 25% non-federal match for approved projects (i.e., the  
 8 State would provide 12.5% and the municipality 12.5%, with FEMA covering 75% of the total project costs).

9 Effective October 23, 2014 Towns must have adopted four flood hazard mitigation measures in order to  
 10 maintain the same level of state funding in the event of such a disaster: 1) Flood Hazard Regulations that  
 11 meet minimum standards for enrollment in the National Flood Insurance Program; 2) the most recent  
 12 Agency of Transportation Road and Bridge Standards; 3) a Local Emergency Operations Plan (LEOP); and  
 13 4) a Local Hazard Mitigation Plan and submit to FEMA for approval.

14 Local Flood Hazard Regulations that include protection of State River Corridors are afforded a greater share  
 15 of State matching funds – the State’s portion of the match is increased to 17.5%.

16 Table 8.1 below shows the “ERAF status” of Towns as of July 2015.

Table 8.1 ERAF Status of Northeast Kingdom Towns as of July 2015						
Towns	ERAF Rate (%)	NFIP	Road and Bridge Stand.	LHMP	LEOP	R.C. Bylaw
Albany	7.5	No	Yes	No	Yes	
Barnet	7.5	Yes	No	No	No	
Barton Town	Pending	Yes	Yes	Yes	Pending	
Barton Village	12.5	Yes	Yes	Yes	Yes	
Bloomfield	7.5	Yes	Yes	No	No	
Brighton	7.5	Yes	Yes	Plan in progress	Yes	
Brownington	7.5	No	Yes	No	Yes	
Brunswick	7.5	Yes	Yes	No	No	
Burke	7.5	Yes	Yes	No	No	
Canaan	12.5	Yes	Yes	Yes	Yes	
Charleston	7.5	No	Yes	Yes	No	
Concord	7.5	Yes	Yes	No	Yes	
Coventry	7.5	Yes	Yes	No	Yes	
Craftsbury	7.5	Yes	Yes	No	No	
Danville	7.5	Yes	No	No	Yes	
Derby	7.5	Yes	Yes	No	No	
East Haven	7.5	No	Yes	No	Yes	
Glover	12.5	Yes	Yes	Yes	Yes	
Granby	7.5	Yes	Yes	No	No	Interim
Greensboro	7.5	Yes	Yes	No	Yes	

**Table 8.1  
ERAF Status of Northeast Kingdom Towns as of July 2015**

<b>Towns</b>	<b>ERAF Rate (%)</b>	<b>NFIP</b>	<b>Road and Bridge Stand.</b>	<b>LHMP</b>	<b>LEOP</b>	<b>R.C. Bylaw</b>
Groton	7.5	Yes	Yes	No	Yes	
Groton Village	7.5	Yes	Yes	No	Yes	
Guildhall	17.5	Yes	Yes	Yes	Yes	Interim
Hardwick	7.5	Yes	Yes	Yes	No	
Holland	7.5	No	Yes	No	Yes	
Irasburg	7.5	No	Yes	No	Yes	
Jay	7.5	Yes	Yes	No	Yes	
Kirby	7.5	Yes	Yes	No	Yes	Interim
Lemington	7.5	Yes	Yes	No	No	
Lowell	7.5	Yes	Yes	No	Yes	
Lunenburg	7.5	No	Yes	No	No	
Lyndon	7.5	Yes	Yes	Plan in Progress	No	
Lyndonville Vill.	7.5	Yes	Yes	Plan in Progress	No	
Maidstone	7.5	No	No	No	No	
Morgan	7.5	No	Yes	No	Yes	
Newark	7.5	No	No	No	No	
Newport Town	7.5	Yes	Yes	No	No	
Newport City	7.5	Yes	Yes	Plan in Progress	Yes	
North Troy Village	7.5	Yes	No	No	Yes	
Norton	7.5	Yes	Yes	No	Yes	Yes
Peacham	7.5	Yes	No	No	Yes	Interim
Ryegate	12.5	Yes	Yes	Yes	Yes	
Sheffield	7.5	No	No	No	Yes	
South Ryegate Vill.	7.5	Yes	Yes	Yes	No	
St. Johnsbury	12.5	Yes	Yes	Yes.	Yes	
Stannard	7.5	Yes	No	No	No	
Sutton	7.5	No	Yes	No	No	
Troy	7.5	Yes	Yes	No	Yes	Interim
UTG	7.5	Yes	Yes	Plan in Progress	Yes	Yes
Victory	7.5	No	Yes	No	No	
Walden	7.5	No	No	No	Yes	
Waterford	7.5	Yes	Yes	Plan in Progress	Yes	
Westfield	7.5	Yes	Yes	No	Yes	
Westmore	7.5	No	Yes	No	No	
Wheelock	7.5	No	No	No	Yes	

1  
2 It is noted that besides the funding benefits under ERAF, each of the four required elements are beneficial on  
3 their own. As previously noted, membership in the NFIP enables residents to secure flood insurance, which  
4 is required if a federally-backed mortgage is sought for the property. It also lowers rates for all flood  
5 insurance policy holders in Town. It is noted that some Towns may wish to join the National Flood  
6 Insurance Program for the benefits available to residents, but do not have FEMA Flood Insurance Rate Maps  
7 (FIRMs) on which to base local flood hazard regulations. In this case, other data may be developed to  
8 establish the area that would be subject to local flood hazard regulations. Peacham is one such town in the  
9 region that never had FIRMs, but was able to join the NFIP through the use of data established by stream  
10 geomorphic assessment reports.

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## 11 12 **GOALS AND STRATEGIES FOR FLOOD RESILIENCE**

### 13 **FLOOD RESILIENCE GOALS**

- 14 • Increase awareness of the most effective means of reducing future flood damage, as identified in  
15 Tactical Basin Plans and Stream Geomorphic Assessments (River Corridor Plans)
- 16 • Protect areas identified and designated as flood plains, river corridors and land adjacent to streams
- 17 • Mitigate risks to public safety, critical infrastructure, historic structures, and municipal investments.

### 18 **FLOOD RESILIENCE STRATEGIES**

- 19 • Coordinate with the County Conservation Districts in hosting flood mitigation workshops for  
20 residential landowners and business owners, to educate them on measures to reduce flood risk and  
21 damage.
- 22 • Encourage Towns to include restriction of development within River Corridors, as mapped by the  
23 Vermont Agency of Natural Resources.
- 24 • Encourage Towns to amend zoning and subdivision regulations to include limits on clearing and  
25 impervious coverage, and that avoids impacts to wetlands and steep slopes (slopes greater than 20%).
- 26 • Encourage Towns to incorporate Planned Unit Development provisions in their bylaws as a means  
27 to minimize impervious coverage and clearing.
- 28 • Encourage towns to engage in a working partnership with adjacent communities to address control  
29 of stormwater runoff and actions that will allow rivers and streams to regain access to floodplains.
- 30 • Assist Towns in seeking funding to implement hazard mitigation projects identified in plans.

31