

Vermont Economic Resiliency Initiative [VERI]

Brattleboro, VT

Community Report
July 2015



Acknowledgements

The Vermont Economic Resiliency Initiative was partially supported by US Department of Commerce, Economic Development Administration (EDA). Thanks to EDA's Matthew Suchodolski and Debra Beavin for their support and guidance of the project.

Vermont Department of Housing and Community Development

- Chris Cochran
- Wendy Rice
- Ken Jones
- Faith Ingulsrud
- Melissa Prindiville
- Lucie MacAskill
- Annina Seiler
- Richard Amore

Vermont Department of Environmental Conservation

- Mike Kline
- Todd Menees
- Shannon Pytlik
- Josh Carvajal
- Marie Caduto

Vermont Agency of Transportation

- Joe Segale
- Jonathan Croft

Windham Regional Commission

- Jeff Nugent
- Kim Smith

Two Rivers-Ottawaquechee Regional Commission

- Peter Gregory
- Pete Fellows

Rutland Regional Planning Commission

- Laura Keir
- Ed Bove
- Steve Schild

Central Vermont Regional Planning Commission

- Daniel Currier
- Gail Aloisio

Northwest Regional Planning Commission

- Bethany Remmers
- Taylor Newton

Thanks also to the Vermont Department of Labor, the Vermont Division of Emergency Management and Homeland Security, Economic & Policy Resources, Inc, and the Office of the State Auditor for their assistance with data gathering and analysis.

Thanks to the following consulting firms for their work developing the five community reports and recommendations. Their dedication, creativity and skill not only provided a strong work plan for the municipalities, but serve as models for all Vermont communities. Special thanks to Mary Nealon for her leadership in bringing this talented team together and Amy Sheldon for her work as lead in Brattleboro.

- Bear Creek Environmental, LLC: Mary Nealon
- DuBois & King, Inc.: Matt Murawski
- Fitzgerald Environmental Associates, LLC: Evan Fitzgerald
- Landslide Natural Resource Planning, Inc.: Amy Sheldon
- Milone & MacBroom, Inc.: Roy Schiff

Thanks to the Town of Brattleboro and all those that participated in stakeholder meetings, community forums, morning coffee meetings and took the time to review, edit, comment and provide the local perspective for this project. Thanks to the members of the General Assembly, Selectboard, Planning Commission, town staff, the Chamber of Commerce, businesses and citizens. Your participation greatly improved the report.

Noelle MacKay, Commissioner of Housing and Community Development

Table of Contents

Vermont Economic Resiliency Initiative (VERI) Brattleboro Executive Summary	i
List of Acronyms	1
Glossary of Terms	2
Project Overview	4
Why was Brattleboro Selected?	5
Study Area	5
Research and Outreach	6
Flood History and Town Accomplishments	9
Flood History and Risk	9
Town Accomplishments	11
Town Wide Flood Policy.....	11
Vermont - Downtown Action Team (V-DAT)	12
Site Specific Accomplishments	13
Strategies and Projects to Protect Brattleboro.....	14
Municipal Policy and Program Recommendations	14
Specific Project Recommendations	16
Channel and Floodplain Improvements.....	17
Infrastructure Improvements.....	18
Public Safety Improvements	20
Conceptual Project Designs to Protect Brattleboro	21
Remove At-risk Sewer and Water Lines within the Whetstone Brook Channel.....	21
Overview and Objectives.....	21
Data Analysis and Results.....	21
Conceptual Design	22
Steps for Project Implementation	22
Project Benefits	23
Conserve Eight Acres of Floodplain Upstream of Downtown	23
Overview and Objectives.....	23
Data Analysis and Results.....	23
Conceptual Design	23
Steps for Project Implementation	24
Project Benefits	25
Next Steps.....	26
Education and Outreach.....	27
What Can Individuals Do to Reduce Their Risks?	29
Steps to Reduce Risks	29
What Can Businesses Do to Reduce Their Risks?	31
Steps to Reduce Risks	31
References.....	34

Figures and Tables

Figure 1: Study area	5
Figure 2: Attendees at the first community forum	7
Figure 3: Field assessment of existing conditions	8
Figure 4: Example of floodplain formation in West Brattleboro	8
Figure 5: Damage to downtown, 1869 Freshet (Brattleboro Historical Society)	9
Table 1: Estimated Number of Businesses, Employees & Multi-family Residences At-risk	10
Figure 6: Homemade flood gauge at Glen Park assists residents in estimating flood risk and knowing when to evacuate.....	10
Figure 7: Town Plan Cover, 2013.....	11
Table 2: How Brattleboro Met its ERAF Match.....	12
Table 3: Categories of Municipal Policies and Programs.....	15
Table 4: Mitigation Project Types.....	17
Figure 8: View of Eastern Williams Street Bridge from upstream. Left abutment eroded during Irene, sediment buildup shown right.	19
Figure 9: Misaligned VT Route 9 Bridge (2008) before Tropical Storm Irene.....	19
Figure 10: Mobile Home in floodway lost during Irene.....	20
Figure 11: Sewer line crossing Whetstone Brook, before it washed out in Tropical Storm Irene.....	21
Figure 12: Eight acres of floodplain upstream of downtown	24

Appendices

Appendix A: Town of Brattleboro and Whetstone Brook Data Sources	
Appendix B: Tropical Storm Irene Damages and Developed Floodplain Map	
Appendix C: V-DAT One-Page Visual Summary of the Top Recommendations for Brattleboro	
Appendix D: Tables of Projects to Protect Brattleboro	
Appendix E: Maps of Projects to Protect Brattleboro	
Appendix F: EPA Flood Resilience Checklist	
Appendix G: Table of Municipal Policy and Program Recommendations	
Appendix H: Economic Zones Map	
Appendix I: Bridge Summary Table	
Appendix J: Eastern Williams Street Bridge Conceptual Design	
Appendix K: Housing Study	
Appendix L: Map of Sewer and Water Lines in the Floodway	
Appendix M: FIRM Cross Sections and Change in Flood Level for Floodplain Restoration	
Appendix N: Community Forum Meeting Notes	

Vermont Economic Resiliency Initiative (VERI)

Brattleboro Executive Summary

In communities around Vermont, rapidly melting snow and torrential downpours can bring nightmares of washed out bridges, closed roads, flooded basements and shuttered businesses. To calm these fears, Vermonters have been working to better understand the flood risks they face and identify and implement projects to reduce, avoid or minimize these risks and flood damages. The goal: to protect lives, help businesses remain open and reduce costs to taxpayers for repetitive repair to infrastructure.

After Tropical Storm Irene, Governor Peter Shumlin challenged us to “build back stronger than Irene found us.” The Vermont Economic Resiliency Initiative (VERI) is designed to help meet that challenge. It is modeled after a successful project in Bennington, Vermont that minimized business interruption and saved taxpayers money by substantially reducing flood recovery costs (DHCD, 2015). With funding from the US Department of Commerce, Economic Development Administration (EDA), the Agency of Commerce and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched VERI to help ensure Vermont recovers quickly and remains open for business after disaster strikes.

In the first phase of the project, the VERI team evaluated and ranked areas where economic activity and associated infrastructure are at high risk of flooding. Based on this state-wide assessment, input from the team’s economic steering committee and interest from local municipalities, five areas in seven communities (Barre City and Town, Brandon, Brattleboro, Enosburgh Town and Village, and Woodstock) were selected for a more detailed analysis of the local flood risks to the community and businesses.

Brattleboro was selected for the VERI project because of its role as a regional economic center – it has the fourth highest level of economic activity in the State (tied with Rutland). It is also located on Routes 5 and 9, critical north-south and east-west travel corridors that are particularly vulnerable to floods. Finally, Brattleboro has completed a number of flood protection projects identified in the 2008 Whetstone Brook River Corridor Plan and is working to floodproof downtown buildings.

The VERI team hosted community meetings and has worked directly with local leaders, municipal staff, local businesses and interested citizens to determine the locations of greatest flood risk and associated cost, identify potential projects and highlight the work communities have accomplished to date to reduce the impact of floods. Based on this community insight, along with data collection and analysis, the team evaluated local flood risk to business and infrastructure and identified strategies and projects Brattleboro can implement to minimize rebuilding and recovery costs and ensure businesses stay open -- saving jobs and maintaining the local economy.

This report summarizes the team’s work and identifies town-wide policy and program recommendations as well as site specific projects -- including five that river scientists and engineers ranked as high priority:

Top Municipal Policy and Program Recommendations

Top recommendations include the following:

- **Achieve a Higher Community Rating System (CRS) Rating:** The Town of Brattleboro should take steps to achieve a higher rating within FEMA’s CRS based on land preservation efforts, outreach efforts, elevation certificates, higher standards in the floodplain ordinance, and stormwater regulations. A higher rating will result in reduced flood insurance rates for residents and businesses.
- **Identify Areas for Conservation:** The Whetstone Brook and the Crosby Brook River Corridor Plans both identify potential riparian easement sites. Various agencies and organizations working in the community, including the Windham County Natural Resources Conservation District, Brattleboro Conservation Commission, and Vermont Land Trust, can identify and work with willing landowners to establish those riparian easements to prevent future development in flood prone locations.
- **Regulate Development in Fluvial Erosion Hazard Areas:** Much of the flood damage in Vermont is caused by bank erosion from swollen rivers within river corridors. Stream banks can fail causing structures to be undermined or fall into the river. Regulating development in the areas mapped as Fluvial Erosion Hazard Areas by the Agency of Natural Resources (ANR) as part of a Stream Geomorphic Assessment would reduce flood risk and increase public safety. Additionally, the regulations should be written for the town to achieve a higher state Emergency Relief Assistance Fund (ERAF) rating.
- **Regulate Grading and the Clearing of Trees and Plants on Slopes Greater than 15%:** These areas are particularly susceptible to erosion and allowing these practices puts the entire community at risk.

High Priority Specific Project Recommendations

Channel and Floodplain Management: These are projects that lower the risk of flooding and/or erosion to properties along the brook through the improvement of natural river and floodplain functions.

- **Conserve Remaining Undeveloped Floodplain to Protect the Downtown Area and Businesses (Site 16):** The community should conserve eight acres of remaining undeveloped floodplain upstream of the downtown near Williams Street. The community could also further increase flood water, sediment and debris storage in this area by creating a flood chute or by lowering (cutting) the elevation of this upstream area.

In downtown, Tropical Storm Irene destroyed or damaged roads and sidewalks, caused minor damages to eight buildings and major damages to three buildings, including four businesses that employ approximately 52 people. Increasing the capacity of this undeveloped floodplain to store water could reduce local flood elevations by four to five feet in the downtown. Further study of the benefits may reveal flood reduction downtown that may reduce the cost of flood insurance. It will also help protect Williams Street, an important access for these local businesses and an alternate route to downtown.

Infrastructure Improvements: These types of projects lower the risk of flooding and/or erosion to utilities, roadways and other municipal or state-owned infrastructure.

- **Manage Sediment at Eastern Williams Street Bridge (B35, at West Street):** To reduce threats or damage to the bridge, remove the plug of sediment from the right (facing downstream) bridge opening to increase channel capacity, reduce erosion and the likelihood of debris jams during high water flows. Williams Street provides important redundancy to the downtown transportation network in addition to access for the businesses and employees mentioned above.
- **Address Alignment Issues at VT Route 9 Bridge (B51, near Cumberland Farms) in West Brattleboro:** The Whetstone Brook flows through this bridge at an angle which causes erosion on the right abutment (facing downstream). This alignment issue required the repair of the streambank after Tropical Storm Irene. Armoring this bank with riprap and improving the road/river alignment would help keep VT Route 9 open for employers, employees, residents and emergency responders. In addition to keeping West Brattleboro and the State Police barracks connected to Brattleboro, VT Route 9 is the primary, and therefore critical, east/west economic connector for people and commerce in southern Vermont.
- **Remove At-risk Sewer and Water Lines within the Whetstone Brook Channel:** Public health and threats to business operations require responsible location of the sewer and water lines.

Public Safety Improvements: These projects lower the risk of flooding and/or erosion to properties by avoiding future flood risks.

- **Pursue Buyouts or Relocation Strategies for At-risk Properties (Sites 4, 10 & 6):** Three areas of Tri-Park Mobile Home Park – two in Mountain Home and one in Glen Park, were identified in the Whetstone Brook River Corridor Plan as vulnerable to severe flood damages due to their location. In Mountain Home alone, there are currently 93 homes in the 100-year floodplain, 20 of which are in the floodway. Many homes were washed away or damaged by Tropical Storm Irene and they remain in harm's way. While moving people out of harm's way is an expensive and time consuming process, is an important goal to pursue and implement as funding and other opportunities allow.

Three of these high priority projects -- managing sediment at the Eastern Williams Street Bridge, conserving eight acres of floodplain near downtown and removing the sewer and water lines from the floodway -- are further detailed as conceptual designs in this report to help the community take the next steps and to create model project designs to help other communities learn from this project.

Next Steps

As part of the ongoing community discussion regarding the VERI effort, the team recommends the following steps to incorporate the community's input into the final prioritization and advance the projects over time:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization;
- Prioritize one to two projects to pursue each year with assistance from the Vermont Department of Environmental Conservation and Windham Regional Commission staff to identify appropriate funding sources and partners;
- Apply for one to two grants each year to advance project development and/or designs;
- Implement projects as funding allows; and
- Monitor project success.

Irene taught us many lessons – a key one was that no one individual, business, organization, town or state agency can address and tackle large and complicated projects alone. Reducing the risk of future floods in Brattleboro will require partnerships, funding and time to implement. The Agency of Commerce and Community Development, its sister agencies and the Windham Regional Commission are committed to helping Brattleboro take the steps outlined in this report to save lives and protect jobs and the economy from future storms and floods.

Flooding due to severe storms will happen again, the question is how can we best reduce the recovery costs to communities and ensure businesses remain open.

List of Acronyms

ACCD – Vermont Agency of Commerce and Community Development

ANR – Vermont Agency of Natural Resources

CDBG-DR – Community Development Block Grant – Disaster Recovery

CRS – FEMA Community Rating System

DHCD – Vermont Department of Housing and Community Development

DEC – Vermont Department of Environmental Conservation

EDA – US Economic Development Administration

EPA – US Environmental Protection Agency

ERAF – Emergency Relief Assistance Fund

FEH – Fluvial Erosion Hazard

FEMA – Federal Emergency Management Agency

GPS – Global Positioning System

HMGP – Hazard Mitigation Grant Program

HMP – Hazard Mitigation Plan

LNRP – Landslide Natural Resource Planning, Inc.

NFIP – National Flood Insurance Program

SFHA – Special Flood Hazard Area

USGS – United States Geological Survey

VERI – Vermont Economic Resiliency Initiative

V-DAT – Vermont Downtown Action Team

VTrans – Vermont Agency of Transportation

WCNRC – Windham County Natural Resources Conservation District

WRC – Windham Regional (Planning) Commission

Glossary of Terms

Terms are bolded the first time they appear in the text.

100-Year Floodplain – The area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. Also called 100-Year Flood Zone or 100-Year Flood Hazard Area.

500-Year Floodplain – The area that will be inundated by the flood event having a 0.2% chance of being equaled or exceeded in any given year. Also called 500-Year Flood Zone or 500-Year Flood Hazard Area.

Base Flood Elevation – The computed elevation to which floodwater is anticipated to rise during a 100-year flood.

Berm – An artificial ridge or embankment, e.g., a raised bank bordering a river that prevent flow out of the main channel.

Community Rating System (CRS) – Program that provides a flood insurance premium rate reduction based on a community's floodplain management activities. CRS recognizes community floodplain management activities that exceed the minimum NFIP standards. Besides the benefit of reduced insurance rates, CRS floodplain management activities enhance public safety, reduce damages to property and infrastructure, avoid economic disruption and losses, and protect the environment.

Culvert – A pipe or tunnel underground, usually under roads, that transports flowing water from one side to the other

Emergency Relief Assistance Fund – This program allows towns in Vermont to increase the amount of state aid money they could receive as a match to federal aid for post-disaster recovery projects that enhance public safety, reduce damages to property and infrastructure, avoid economic disruption and losses, and protect the environment. **Erosion** – The wearing away of rock or soil by flowing water.

Floodplain – Area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge.

Floodway – The area immediately adjacent to the river channel that must remain open to allow floodwaters to pass.

Flood Chute – A short cut taken by a river or similar waterway during high water, rather than following the normal meandering route

Flood Resiliency – The ability of individuals, communities, organizations and states to adapt to and recover from flooding hazards without compromising long-term prospects for development.

Fluvial Erosion Hazard Area – Area delineated with field data by the Vermont Rivers Program adjacent to rivers and streams to provide room to restore and maintain the natural stability of a river and avoid property damage. These areas are often at higher risk of erosion.

Hazard Mitigation Plan – A document and planning process that provides actions to reduce the long-term risk to human life, property, and the economy from natural disasters.

Mitigation – Any sustained action taken to reduce or eliminate the long-term risk to life and property from hazard events. It is an on-going process that occurs before, during, and after disasters and serves to break the cycle of repetitive damage and repair.

National Flood Insurance Program – A federally funded and locally implemented program to reduce the impacts of flooding through individual insurance policies and incentives for floodplain regulations.

Riparian Buffer – Mixed composition, vegetated land adjacent to a stream separating it from other land uses.

Special Flood Hazard Area – The area that will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year. Also called 100-Year Floodplain, 100-year Flood Zone or 100-Year Flood Hazard Area.

State River Corridor – Area delineated by the Vermont Rivers Program adjacent to rivers and streams to provide room to restore and maintain the natural stability of a river and avoid property damage. These areas are often at higher risk of erosion.

Project Overview

In May 2013 the Vermont Agency of Commerce and Community Development (ACCD) received disaster recovery funding from the US Economic Development Administration (EDA) for the Vermont Economic Resiliency Initiative (VERI). The overarching goal of the project is to ensure that businesses and communities bounce back quickly when disaster strikes, saving time and money in recovery costs.

The objectives of VERI are to:

1. Analyze threats to areas of economic activity and their associated infrastructure;
2. Develop plans to reduce impacts and avoid future losses and costs; and
3. Identify projects that communities and businesses can implement that avoid, minimize or reduce their flood risk and thus ensure businesses stay open and communities minimize costs.

VERI is led by ACCD's Department of Housing and Community Development (DHCD) in partnership with the Agency of Natural Resources (ANR), Agency of Transportation (VTrans), and Vermont's Regional Planning Commissions, which in Brattleboro is the Windham Regional Commission (WRC). Early in the process, these agencies mapped places where flood hazard risks intersect with areas of economic activity and infrastructure. Five priority communities were selected for a detailed assessment of those risks: Barre City and Town, Brandon, Brattleboro, Enosburgh Village and Town, and Woodstock. A river scientist and engineering team consisting of five consulting companies - Bear Creek Environmental, LLC, DuBois & King, Inc., Fitzgerald Environmental Associates, LLC, Landslide Natural Resource Planning, Inc., and Milone & MacBroom, Inc. - were hired to analyze the rivers and assist in developing recommendations to reduce the vulnerability of infrastructure and businesses to flood damage.

The primary objective of the focus area assessments is to develop strategies and projects to make businesses and the communities more resilient to floods and other disasters.

A number of factors played a role in the selection of the five communities for more detailed assessments. First, the project team ranked towns across the state by flood risk, economic activity and infrastructure at risk. Then the team looked at the 20 highest ranking communities and removed any that had undergone or had funding for similar analysis (i.e., Bennington and Waterbury). Next the team strived to select five pilot communities that represented different economic profiles (i.e., agriculture, tourism, downtowns) as well as different sizes. Other considerations included risk of future damage, economic factors, and level of community engagement and interest. Together, these factors helped determine the five pilot communities selected.

Why was Brattleboro Selected?

Brattleboro was selected as one of the pilot communities for the following reasons:

- It is a regional economic center with total employment in 2013 of 10,698 at 731 businesses;
- The community has the fourth highest level of economic activity in the State (tied with Rutland) and it is a state designated downtown;
- Brattleboro has critical transportation infrastructure at risk from floods. Failure of the transportation network would impact employees and customers trying to get to businesses and slow the flow of goods and services;
- Whetstone Brook flooding threatens numerous commercial buildings and infrastructure; and
- Brattleboro has successfully identified and reduced flood and erosion risks in the past.

Study Area

Located along the Connecticut River in the southeastern part of the state, Brattleboro is Vermont's seventh largest town with a population of 12,046 (US Census Bureau, 2010) in 32 square miles (20,490 acres). It is bisected east-west by the Whetstone Brook and bounded by Dummerston to the north, the Connecticut River and New Hampshire to the east, Guilford and Vernon to the south and Marlboro to the west. The western quarter of town is bounded by the steep forested slopes of the Green Mountains where the Whetstone Brook originates in Marlboro. The valley is naturally narrow and the brook is further constrained by the location of VT Route 9 adjacent to the Brook. As the river flows east, the slope eases and the valley widens in West Brattleboro. This study is focused on the lower 5.7 miles of the Whetstone Brook that includes downtown Brattleboro, West Brattleboro Village and West Brattleboro, all located along the Whetstone Brook (Figure 1).

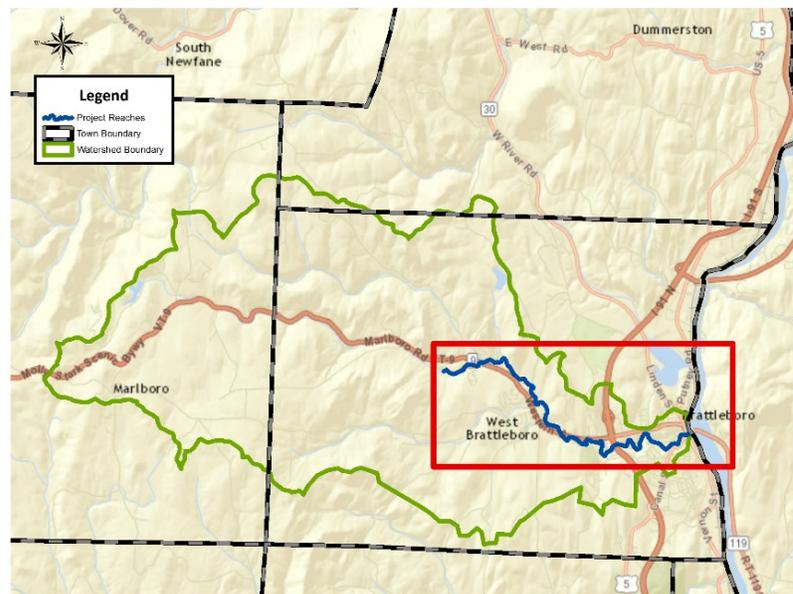


Figure 1: Study area

Brattleboro is a regional transportation hub with the railroad, US Route 5 and Interstate 91 that run north/south along the Connecticut River in the eastern quarter of town. VT Route 9 travels west to Wilmington (and its ski areas), Bennington and Albany, New York and east into New Hampshire, providing the key east-west regional travel corridor for commerce in the southern part of the state. VT Route 30 follows the West River through Windham County in a northwest direction out of Brattleboro, connecting towns along the West River Valley, Manchester in western Vermont, and

US Route 7 on Vermont's western side. Routes 9 and 30 are important year-round access routes to Haystack Mountain, Mount Snow and Stratton Ski Resorts, along with Bromley and Magic Mountains, drawing large numbers of visitors and second home owners (WRC, 2014b).

Urban development throughout the study area is significant – in the downtown it is greater than 60% of the land area; in West Brattleboro it is greater than 20%; and in West Brattleboro Village it is greater than 40%. Watersheds with more than 10% developed land are known to experience increased run-off that can result in permanent changes to the width, depth and slope of the river channel. Despite intense commercial and residential development, agriculture and forestry remain important parts of the economy and over 2,776 acres of land in the upper reaches of the watershed in Brattleboro and Marlboro are conserved (LNRP, 2008).

VT Route 9 is critical to commerce and is the most significant highway located in the study area. While it is adjacent to the Whetstone Brook in the mountainous terrain in Marlboro and the western third of Brattleboro, once the slope eases and the valley widens, the highway is mostly outside of the **floodplain**, though it does cross the Brook twice. The same cannot be said for the town water and sewer line with 8,445 feet of sewer pipe and 4,881 feet of water line at risk in the **floodway**. However, the sewer and water treatment facilities are located outside of the flood prone areas of the Whetstone Brook.

The Vermont State Police Barracks in West Brattleboro is on the southern edge of the floodplain. It is separated from the town's main population centers by two VT Route 9 Whetstone Brook bridges. The West Brattleboro Fire Station is outside of the floodplain, but is located between the two VT Route 9 bridges. It is separated from the main fire station (Central Station), by one of those bridges. Central Station is located downtown, north of and outside of the floodplain. Within the study area, three-phase power follows VT Route 9 and Williams Street, crossing Whetstone Brook four times in the study area. All these are key services and essential to first responders in the event of a disaster.

Research and Outreach

The team kicked-off the project in August 2014 at a meeting with town staff to share information about flood risk and ongoing efforts to reduce that risk. DHCD Commissioner Noelle MacKay emphasized the overall objective of helping businesses bounce back rather than break after disasters. Following this meeting, the team reviewed existing information about the town, Whetstone Brook, and associated community hazard planning (see table of data sources in Appendix A).

Following the kick-off meeting, DHCD and the Windham Regional Commission (WRC) hosted a community forum on October 15, 2014 (Figure 2). Community members, town officials, business owners and homeowners from the region attended and learned more about the background of the VERI project from Commissioner MacKay. Amy Sheldon, from Landslide Natural Resources Planning, Inc., provided an overview of the Whetstone Brook. Then the floor was open for ideas and questions from the community members.

At that forum, Brattleboro community members highlighted successfully completed and ongoing flood resilience projects including:

- The conservation of the Locke Field (below Sunset Lake Road and behind Chelsea Royal Diner) to protect critical floodplain from development.
- The Vermont Downtown Action Team's (V-DAT) post-Irene work developing a downtown master plan, as well as branding and marketing campaigns.
- The construction of a new downtown food cooperative designed with flooding in mind -- including infrastructure to minimize stormwater run-off from the site.



Figure 2: Attendees at the first community forum

Participants also highlighted areas vulnerable to flooding and erosion including:

- Flat Street is a low point along the brook and continues to see flooding on a more frequent basis.
- Debris catches at the Main Street Bridge because the bridge is narrow and the water has to flow around an 'S' curve and the overflow around the bridge causes flooding to local businesses.
- All the bridges upstream of and including VT Route 9 Bridge by Melrose Street are undersized. Failure of a VT Route 9 bridge would impact a critical transportation corridor that, according to VTTrans, carries over 16,000 vehicles per day.

In the fall of 2014, the river scientist and engineer on the team spent a day walking the entire project area with the Phase 2 **Stream Geomorphic Assessment** data and the post Tropical Storm Irene damage inventory in hand (Figure 3). Global Positioning System (GPS) points and photos were taken along the route. The team noted the following:

- Location of vulnerable structures and utility poles;
- Formation of new floodplain adjacent to areas that were dredged during Irene;
- Areas where the sewer line broke and failed during Tropical Storm Irene; and
- Areas of new sediment build up.

Earlier studies of the Whetstone Brook informed the work of the team. A 2008 **River Corridor Plan** (LNRP, 2008) helped to establish a baseline understanding of the pre-development characteristics of the Brook and its watershed, as well as the impacts of existing development. The plan made recommendations to help the community reduce future floods and enjoy the many benefits of the Brook (Figure 4). This River Corridor Plan, along with the Town of Brattleboro All **Hazards Mitigation Plan** (Brattleboro Planning Services Department, 2014), an inventory of the post-Tropical Storm Irene damages and the Brattleboro Town Plan and land use regulations were all utilized in developing the recommendations made in this report. In addition to those documents, 36 US Geological Service (USGS) flood elevation points helped evaluate the extent of flooding during Tropical Storm Irene.



Figure 3: Field assessment of existing conditions

The VERI analysis differs from the 2008 Whetstone Brook River Corridor Plan as it focuses on flooding impacts to individual businesses, the overall economy of the region and the cost of repetitive repairs to infrastructure. Stepping back and looking at Brattleboro as a regional economic center brought to the forefront the necessity of improving and protecting the transportation corridors and maintaining redundant transportation networks. Also, significant portions of the



Figure 4: Example of floodplain formation in West Brattleboro

sewer and water lines - that thousands of people and hundreds of businesses depend upon - are located in the river corridor making them particularly vulnerable to damage and failure during flood events.

Businesses in Brattleboro and the region depend on the VT Route 9 corridor. Many of the most vulnerable transportation structures on VT Route 9 are located outside of the VERI study area and VTrans is working to protect and ensure that this critical transportation corridor remains open for business when the next flood occurs.

Flood History and Town Accomplishments

Flood History and Risk

It is difficult to find specific historic information about flooding in Brattleboro, though the National Weather Service mentions Brattleboro in all of Vermont's storms of record, including the 1869 "Freshet," and the 1927, 1938, 1973 and 2011 floods (Figure 5)(NWS, 2014). Flood elevation measurements taken following Tropical Storm Irene indicate that it was between a 50 and 100-year flood event (Schiff, 2012). There is evidence throughout the watershed of historic channel straightening, dredging and berming – practices that, in large part, were repeated following Tropical Storm Irene.

There were 35 years between the major floods of 1938 and 1973 and 38 years between the major floods of 1973 and 2011. Between these major flood events, many smaller flood events occurred, but were mostly contained within the existing, often incised or over-widened channel. This can lead to a sense of complacency regarding development in the adjacent floodplain area. In fact, the rate of development increased in the most flood prone areas in the watershed between these major flood events. However, with precipitation patterns changing and large storm events becoming more frequent, future development in the floodplain should be minimized. In the past five years, at least one county in Vermont was declared a federal disaster each year. It's therefore important to take steps today to protect the community and its economy from the inevitable.

Ice jams are common on the Whetstone Brook, causing inundation and leading to road closures and damage to homes in Mountain Home Park. The most recent jam was at the Westgate Bridge in 2013/2014 (WRC, 2014a).

The team inventoried developed and undeveloped floodway and floodplain as part of this project.



Figure 5: Damage to downtown, 1869 Freshet (Brattleboro Historical Society)

What is the Floodway?

The floodway is the area immediately adjacent to the channel that must remain open to allow floodwaters to pass.

What is the 100-year Floodplain?

The 100-year floodplain is also called the Special Flood Hazard Area, and is the base floodplain shown on FEMA maps.

What is the State River Corridor?

The River Corridor is the area delineated by the Vermont Rivers Program adjacent to rivers and streams that provide functions that restore and maintain natural channel stability. These areas are often at higher risk of erosion and/or flooding.

Within the study area, there are 120 acres of floodway, with 22 acres (18%) developed. There are another 304 acres of floodplain, with 144 (47%) acres developed. There are approximately 300 buildings located in the floodplain in the study area and 50 in the floodway.

Table 1 provides an estimated number of businesses and employees that work in buildings in the various flood zones along with the number of single-family residents. There are approximately 58 licensed businesses located in the **100-year floodplain** and 10 in the **500-year floodplain**.

Development in the floodway and floodplain reduces the area available for storing water, sediment and ice during flood events and increases flooding downstream. The cost of building in the floodplain must be evaluated, not only in the context of removing active areas of floodplain that can store flood waters and sediment during floods, but also by understanding that new development will increase run-off and exacerbate downstream flood effects.

Table 1: Estimated Number of Businesses, Employees & Multi-family Residences At-risk			
	Floodway	100-year Floodplain	State River Corridor
Number of Licensed Businesses*	2	68	31
Number of Commercial Buildings**	3	49	24
Number of Employees*	6	711	204
Single-Family Residences**	6	73	55
Multi-Family Residences**	5	43	27
Mobile Homes**	35	111	30

*The Town of Brattleboro has a business licensing program. Not all businesses participate. The number of employees is based on voluntary information provided by licensed businesses who choose to share.
 **This data is from the statewide E911 database.

There are approximately 50 buildings in the floodway throughout the study area and many of those are residences in West Brattleboro. Concern for flooding is so great that they have created their own flood gauge (Figure 6) to assist with evacuation notification.

According to DHCD, damages from Tropical Storm Irene to Brattleboro roads, bridges, public buildings, utilities, and recreation facilities were \$1.5 million dollars. Appendix B provides a map of the locations of damaged property from Tropical Storm Irene in the study area.

Irene damaged 174 buildings along the Whetstone Brook (WRC, 2011). Of those buildings, 29 were businesses. The remainder were residences. There were 20 incidences of road damage, 13 incidences of debris on the road and 16 erosion sites



Figure 6: Homemade flood gauge at Glen Park assists residents in estimating flood risk and knowing when to evacuate

documented. Additionally, 16 bridges were damaged including two town highway bridges that were completely washed away.

Town Accomplishments

Town Wide Flood Policy

Brattleboro’s Town Plan identifies what the community cares about – its shared values and priorities – and builds a vision for Brattleboro’s future based on this information. It also identifies current conditions and gathers public input to inform future public investments.

The Land Use section of the Town Plan, adopted in 2013, identifies a number of important flood and erosion hazard goals and policies, including:

“Promote development of a future land use pattern that promotes public health and safety against floods, ensures the viability of agricultural and forestry economies, protects natural resources, promotes transportation accessibility, and reinforces a compact development pattern and reduce the impact of flooding and erosion” (Brattleboro Planning Services Department, 2013).

The Plan goes on to articulate the following specific policies:

- Provide the highest degree of flood protection at the least cost, through the identification and accommodation of natural flooding and channel migration processes posing hazards to life or property.
- Implement strategies within the watershed that reduce the environmental, health, and welfare hazards associated with flooding.

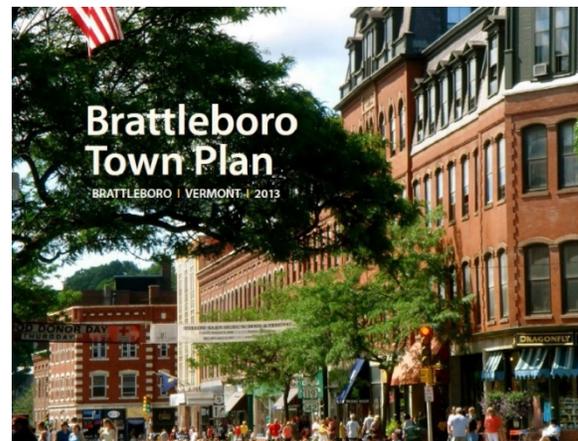


Figure 7: Town Plan Cover, 2013

The Town of Brattleboro should be commended for the work they have done to address flooding and related impacts thus far. The Town is one of only three communities in Vermont that participates in the Federal Emergency Management Agency (FEMA) **Community Rating System (CRS)**. This federal program recognizes community floodplain management activities that exceed minimum **National Flood Insurance Program (NFIP)** standards. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions.

The town also has a full-time zoning administrator who also serves as the floodplain administrator. The Town of Brattleboro website <http://www.brattleboro.org/> has a “Flood Hazard Information” page. The link to this page is clearly placed on the home page, with the text “Emergency Services & Flood Preparedness.” As indicated, the Town of Brattleboro has higher standards than FEMA

minimums in their floodplain ordinance. They also have shore land regulations along the Connecticut River and West River.

In 2014, the State of Vermont established an **Emergency Relief Assistance Fund (ERAF)** to provide matching funding for federal assistance after federally declared disasters. This program allows towns in Vermont to increase the amount of state aid money they can receive as a match to federal recovery aid. Towns that take certain steps to become more prepared are eligible for increased state money. Certain damage costs from federally declared disasters are reimbursed 75% by federal money. The State of Vermont contributes a minimum of 7.5% of the total cost, but if a town takes additional steps, the state aid can increase to 12.5% or 17.5% of the cost, leaving less for the town itself to pay (State of Vermont, 2015a).

In early 2015, the Town of Brattleboro qualified for increased state aid for federally declared disasters. As seen in Table 2 below, the town has policies, plans and programs in place to receive the 12.5% state funding. While it participates in FEMA’s Community Rating System, a key next step to increase the state match to 17.5% is to protect State River Corridors or protect flood hazard areas from new encroachment.

Table 2: How Brattleboro Met its ERAF Match	
Steps to increase State aid to 12.5%	
Participate in the National Flood Insurance Program	Yes
Adopt 2013 State Road & Bridge Standards	Yes
Adopt Local Emergency Operations Plan	Yes
Adopt Local Hazard Mitigation Plan	Yes
Step to increase State aid to 17.5% (one needed to qualify)	
Adopt no new development in a River Corridor	No
Adopt no new development in Flood Hazard areas and participate in the Federal Community Rating System	No

Vermont - Downtown Action Team (V-DAT)

With funding from a Community Development Block Grant for Disaster Recovery (CDBG-DR), DHCD hired a team of experts in community design and economic development and partnered with eight communities, including Brattleboro, to help speed recovery from Tropical Storm Irene. The Vermont-Downtown Action Team (V-DAT) visited Brattleboro on a number of occasions to gather input, develop projects and build consensus on the recommendations. The final reports included short, mid and long-term recommendations to support local economic development efforts. Brattleboro’s complete report and supporting documents are available at http://accd.vermont.gov/strong_communities/opportunities/revitalization/vdat. A one-page visual summary of the top recommendations is included in Appendix C. Recommendations in the V-DAT report should be incorporated into any project prioritization moving forward.

Site Specific Accomplishments

In the past five years, the Town of Brattleboro has implemented 20 projects to decrease flood risk including: lengthening three bridges; replacing six undersized **culverts**, adding three new culverts and improving ditching along two roads to prevent future washouts, removing 22 residences from the **Special Flood Hazard Area** (SFHA) and floodproofing critical infrastructure in the Special Flood Hazard Area, including the Wastewater Treatment Plant and the Spring Tree Pumping Station.

Brattleboro has been a key partner in facilitating a multi-agency planning effort to update the School Crisis Plan with tabletop exercises, staff training, and planned drills. The training effort includes identifying, purchasing and staging materials needed for an emergency response. The plan has become a model in the state.

The town continues to work on buyouts of frequently flooded properties to improve public safety and reduce the recovery costs to individuals, businesses and taxpayers. In a buyout, the town purchases the property from the landowner at fair market value, removes any structures on the property and protects the site from future development.

The Windham County Natural Resource Conservation District (WCNRCD) and the Town of Brattleboro Housing Authority have also made progress on the top six projects identified in the 2008 Whetstone Brook River Corridor Plan (LNRP, 2008) including the following:

- Acquiring and protecting the floodplain behind the Chelsea Royal Diner – completed.
- Working with the Farmer's Market to make their site flood accessible and either make flood ready improvements or find a safer location for the market – ongoing.
- Relocating at-risk housing units in the floodway – ongoing.
- Planting **riparian buffer** along the Whetstone Brook on Vermont Land Trust parcel – completed.

Strategies and Projects to Protect Brattleboro

The team has developed a list of policy and program recommendations and site specific projects to protect Brattleboro's businesses and infrastructure during future floods. Based on data collection and analysis, review of the town plan and bylaws, hazard mitigation plan, previous reports and community input, the team developed a list of flood **mitigation** objectives for the Whetstone Brook in Brattleboro to address town-specific flood damages. These objectives include:

- Keeping VT Route 9 corridor open for commerce, emergency responders and the traveling public;
- Reducing flood effects in the three main economic centers of downtown Brattleboro, the Village of West Brattleboro and West Brattleboro;
- Maintaining water, sewer and power during and after a flood; and
- Protecting businesses and residences from floods.

Using the objectives outlined above, the team developed a list of recommended projects to reduce the impacts of floods (Appendix D). To complement input from the community, the team also created maps to guide the development of project ideas and highlight specific areas with elevated flood risk (Appendices B and E). These maps summarize:

1. Land development located in flood hazard areas; and
2. Damages sustained during Tropical Storm Irene in 2011.

The municipal policy and program recommendations and site specific projects for the community are summarized below.

Municipal Policy and Program Recommendations

Reducing the impacts of floods involves an ongoing process of evaluating and adjusting policies to minimize risks through protection, prevention and education. Accordingly, the VERI team first reviewed Brattleboro's municipal plan, hazard mitigation plans and land use regulations to identify the policies they contain and those that are absent. These documents were reviewed with the goal of identifying gaps and opportunities to improve the flood preparedness, safety and resilience of residents, visitors, businesses and local government.

The team then used the US Environmental Protection Agency's (EPA) **flood resiliency** checklist that was developed from a study in the Mad River Valley in Vermont (US EPA, 2014). This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

The checklist review found that Brattleboro currently employs 33 of 56 items on the checklist, including participating in the National Flood Insurance Program Community Rating System,

adopting floodplain development limits that go beyond FEMA’s minimum standards for SFHAs, and promoting better management of stormwater runoff (including through regulation). (WR RPC, Appendix F).

The results of these reviews identified 26 policy and program recommendations that were then organized into four groups: Land Use Regulations, Community Planning, Emergency Planning, and Education and Outreach. The distribution of the opportunities to improve policies and programs is shown in Table 3, below

Table 3: Categories of Municipal Policies and Programs		
Category	Description	Policies and Programs
Land Use Regulations	Avoid and minimize land use conflicts around watershed resources that help lower the risk of flooding and/or erosion to properties	7
Community Planning	Develop long term goals, recommendations and budgets to improve flood resilience	6
Emergency Planning	Specific projects for supporting mitigation and recovery actions for flooding and other hazards	10
Education and Outreach	Programs targeted at critical businesses and vulnerable populations to educate them about flood risk, mitigation and recovery	3

The results of the plan and policy reviews were then combined and each was scored with either a one (ineffective), three (limited) or five (effective) using the three objectives:

- Reduces flood risk (proposed project lowers the flood level);
- Reduces erosion risk (proposed project lessens the vulnerability to erosion); and
- Protects businesses, infrastructure and property.

The three scores were added to provide a total score. Cost and ease of implementation and input from the community were also considered. To assist the town with implementation, potential partners and funding sources were identified. Each recommendation was further explained and next steps were identified. This information was compiled into easy to read charts found in Appendix G.

The top priority policy and program recommendations were presented at the community forum and local feedback was incorporated into the final prioritization, below.

Top recommendations include the following:

- **Achieve a Higher Community Rating System (CRS) Rating:** The Town of Brattleboro should take steps to achieve a higher rating within FEMA's CRS based on land preservation efforts, outreach efforts, elevation certificates, higher standards in the floodplain ordinance, and stormwater regulations. A higher rating will result in reduced flood insurance rates for residents and businesses.
- **Identify Areas for Conservation:** The Whetstone Brook and the Crosby Brook River Corridor Plans both identify potential riparian easement sites. Various agencies and organizations working in the community, including the Windham County Natural Resources Conservation District, Brattleboro Conservation Commission, and Vermont Land Trust, can identify and work with willing landowners to establish those riparian easements to prevent future development in flood prone locations.
- **Regulate Development in Fluvial Erosion Hazard Areas:** Much of the flood damage in Vermont is caused by bank erosion from swollen rivers within river corridors. Stream banks can fail causing structures to be undermined or fall into the river. Regulating development in the areas mapped as Fluvial Erosion Hazard Areas by the Agency of Natural Resources (ANR) as part of a Stream Geomorphic Assessment would reduce flood risk and increase public safety. Additionally, the regulations should be written for the town to achieve a higher state Emergency Relief Assistance Fund (ERAF) rate.
- **Regulate Grading and the Clearing of Trees and Plants on Slopes Greater than 15%:** These areas are particularly susceptible to erosion and allowing these practices puts the entire community at risk.

Local stakeholders (residents, businesses, planning commission, Selectboard, etc.) are encouraged to review these recommendations and seek assistance from the identified partners and programs and take these steps to reduce flood risk over time.

Specific Project Recommendations

The Whetstone Brook Watershed Stream Geomorphic Assessment and River Corridor Plan (LNRP, 2008) helped inform site-specific flood mitigation project ideas; in many cases projects conceived in the River Corridor Plan prior to the 2011 flooding are still valid today. These River Corridor Plan project locations were evaluated in the field during 2014 to determine if river conditions have changed significantly since the development of the plan in 2008, and whether or how the project concept should be adapted to account for these changes. Additional project ideas were developed through the course of discussions with stakeholders, and additional data analysis and field visits. Projects identified to meet town-specific objectives were organized by the project types outlined in Table 4. A table summarizing projects to protect businesses and infrastructure from flooding is included in Appendix D. Maps depicting the location of each project site in Brattleboro, along with other relevant economic asset and flood hazard information, are also included in Appendix E and H.

To begin, the team screened and scored each project. Each project received a score of one (ineffective), three (limited) or five (effective) for the three objectives:

Table 4: Mitigation Project Types		
Project Category	Description	Projects
Building and Site Improvements	Lowers the risk of flooding and/or erosion to specific properties through improvements to the building and/or surroundings, e.g., sealing off buildings to prevent water infiltration.	4
Channel and Floodplain Management	Lowers the risk of flooding and/or erosion to properties along the river through the improvement of natural river and floodplain functions, e.g., tree plantings along unstable river banks.	7
Infrastructure Improvements	Lowers the risk of flooding and/or erosion to roadways and other municipal or state-owned infrastructure, e.g., increasing the size of bridges and culverts to pass more flood waters.	4
Public Safety Improvements	Lowers the risk of flooding and/or erosion to properties through the avoidance of future flood risks, e.g., FEMA buyouts of improved properties highly vulnerable to flooding.	3

1. Reduces flood risk (proposed project lowers the flood level)
2. Reduces erosion risk (proposed project lessens the vulnerability to erosion)
3. Protects businesses, infrastructure and property

The three scores were added to provide a total score, which was then weighted based on the importance of the project in the region. Projects that would result in a regional economic boost and help keep businesses open were given the greatest weight, while projects that would offer minimal economic benefit to the business economy were assigned a lesser weight. Many of the high priority projects are from the Infrastructure Improvements category, as those at-risk areas potentially affect the greatest number of community members and businesses.

Project partners and stakeholders, including representatives from DHCD, VTrans, ANR, WRC, and the Town of Brattleboro, provided feedback on a draft list of mitigation strategies and their priorities in October 2014. The feedback was incorporated into the prioritization of projects. Below are brief descriptions of the high priority projects from each of the project categories described in Table 4. A summary of efforts to develop conceptual designs for two of the high priority projects follows.

Channel and Floodplain Improvements

Conserve Eight Acres of Undeveloped Floodplain to Protect the Downtown Area and Businesses (Site 16): There are 43.6 acres of floodplain in the downtown and all but 10 acres are developed. The community should consider conserving eight acres of remaining undeveloped

floodplain upstream of the downtown near Williams Street (the remaining two acres are upstream of Elm Street and are frequently flooded).

The community could also further increase flood water, sediment and debris storage in this area by creating a **flood chute** or by lowering (cutting) the elevation of this upstream area.

In the area around Williams Street, Tropical Storm Irene destroyed or damaged roads and sidewalks, caused minor damages to eight buildings and major damages to three buildings, including four businesses that employ approximately 52 people. Increasing the capacity of this undeveloped floodplain to store water could reduce local flood elevations in the downtown by four to five feet. Further study of the benefits may reveal flood reduction downtown that may reduce the cost of flood insurance. It will also help protect Williams Street, an important access for these local businesses and it is an alternate route to access downtown.

The protection of existing floodplain not only allows for the storage of flood water and sediment but it will also prevent new development, which if allowed to happen will increase the likelihood of downstream flooding. Conserving the parcel and potentially reducing the elevation by excavating the floodplain to increase flood storage on the parcel will reduce flood elevations in the area, provide for flood water and sediment storage and dissipate erosive energy from within the channel. This is a moderately difficult project that will take two to five years to complete and cost more than \$200,000. See conceptual designs below for further analysis and next steps.

Infrastructure Improvements

There are 15 bridges located in the VERI Study Area. Seven bridges were described as having had ‘minor erosion’ following Tropical Storm Irene and only the eastern Williams Street Bridge was described as having been damaged (WRC, 2011). It is identified and described as a project below and a conceptual design is presented in Appendix J. Community members and the Town of Brattleboro has indicated that the VT Route 9 Bridge near Melrose Street is a concern. This bridge, with a 55 foot span is sized at approximately the bankfull width, which is the state standard for bridge sizing. A VTrans inspection done on June 17, 2013 states that the “structure is in fair to good condition. Stone should be added to the south end of the arch to help stop the scour” (VTrans, 2014). While this structure is in good shape, it is located in a section of the river that is 100% straightened and the floodplain and floodway contain significant development that was damaged during Irene. The river also jumped its banks upstream of this bridge and flowed across VT Route 9.

See Appendix I for a summary of the span, bankfull channel width and notes on each of the 15 bridges in the study area.

Manage Sediment at Eastern Williams Street Bridge (B35, at West Street)(Site 15): Tropical Storm Irene undermined this bridge that is situated askew to the flow of Whetstone Brook. As a result, the east abutment takes the main force of the current (Figure 8). Additionally, sediment has built up in the right opening (facing downstream) and upstream of the opening. Removing the

sediment to allow the flow to utilize the full bridge span will increase channel capacity and decrease erosive energy. It is likely that regular maintenance will be required at this site until the misalignment is addressed. Williams Street provides redundancy in the transportation connection to the downtown. This project is relatively easy to implement and will cost less than \$10,000. See Appendix J for more details.

Address West Brattleboro Alignment Issues at VT Route 9 Bridge (B51, near

Cumberland Farms): This bridge is misaligned with the Brook causing upstream erosion along the left bank and erosion along the right (facing downstream) bridge abutment (Figure 9). The alignment issue could be addressed by utilizing an existing flood chute upstream of the structure to move the stream flow closer to perpendicular to the bridge. This will reduce scour and help prevent a possible failure. The loss or reduction in traffic on this bridge would affect more than 30 businesses and 140 employees in the immediate vicinity. The State Police Barracks, located west of this bridge, and service to Brattleboro, Wilmington and Bennington is also at risk. Design and implementation of the project is moderately difficult and it is likely to require two to five years to complete. Costs are estimated between \$100,000 and \$200,000. VTrans has identified the eroding upstream left bank as a priority for repairs in their most recent bridge inspection report. This project seeks to balance the competing costs and benefits of utilizing a relatively new bridge structure with the potential for increasing erosive energy downstream. The engineering analysis needs to include an evaluation of the potential impact of straightening the channel on the downtown stream properties. Reaching out to state engineers to discuss the project and potential funding sources and design and permitting process is the logical next step.



Figure 8: View of Eastern Williams Street Bridge from upstream. Left abutment eroded during Irene, sediment buildup shown right.



Figure 9: Misaligned VT Route 9 Bridge (2008) before Tropical Storm Irene

Remove At-risk Sewer and Water Lines within the Whetstone Brook Channel: There are 8,500 feet of sewer line and 4,900 feet of water line located within the floodway of the Whetstone Brook. In 2011, the sewer line broke in two places in the river channel during Tropical Storm Irene releasing 300,000 gallons of untreated waste into the Brook (WRC, 2014a). In addition to being a public health and environmental hazard, businesses cannot function without sewer or water service.

This is an expensive project that will take longer than five years to plan and execute. However, it is necessary given increasing flow and storm events and the amount of water and sewer lines at-risk in the channel. See Appendix L for more details.

Public Safety Improvements

Consider Buyouts or Relocation Strategies for At-risk Properties (Sites 4, 10 & 6): Three areas of Tri-Park Mobile Home Park – two in Mountain Home and one in Glen Park, were identified in the Whetstone Brook River Corridor Plan (LNRP, 2008) as vulnerable to severe flood damages due to their location. In Mountain Home alone, there are currently 93 homes in the 100-year floodplain, 23 of which are in the floodway (Figure 10). Many homes were washed away or damaged by Tropical Storm Irene and others remain in harm’s way. Although removing mobile homes, relocating residents and creating replacement housing is expensive, Tri-Park provides much needed affordable housing including for working households that must be maintained somewhere in the community. Avoiding both personal and public damages associated with flooding is critical to economic resiliency. These same areas were included in an Alternatives Analysis done for the Brattleboro Housing Authority following Tropical Storm Irene by Milone & MacBroom, Inc., (see Appendix K). The report studied Melrose Terrace, Glen Park, Mountain Home and Hayes Court with the following management goals in mind:

- Reduce flood risks;
- Reduce erosion risks;
- Remove flood-prone structures that are repeatedly damaged;
- Maximize the number of housing units;
- Protect existing structures from flooding;
- Re-connect historic floodplain where possible;
- Maximize the ease of construction;
- Develop a project with straight forward permitting needs; and
- Control project costs.



Figure 10: Mobile Home in floodway lost during Irene

The Brattleboro Housing Authority and Housing Vermont are developing 55 units of replacement housing and relocating the majority of the residents of Melrose Terrace to a building in an area safe from flood risks, known as Red Clover Commons. With the help of a DHCD funded consultant, the Tri-Park Cooperative is currently examining the infrastructure needs of the park and identifying the possibilities and operational challenges associated with relocating or elevating the at-risk mobile homes. While moving people out of harm’s way is an expensive and time consuming process, and one that is disruptive to peoples’ lives, it is an important goal to pursue and implement as funding and other opportunities allow.

Conceptual Project Designs to Protect Brattleboro

Using input from the community and the team’s professional judgment of projects that would provide multiple benefits, three projects were selected to advance to the conceptual design stage. These projects include managing sediment at the Eastern Williams Street Bridge (see Appendix J for the conceptual design), removing sewer and water lines in the Whetstone Brook channel, and conserving eight acres of floodplain upstream from the downtown. The conceptual designs will require further design and engineering work to advance toward implementation. If the community wishes to advance the projects, the designs provide enough detail to apply for grants.

Remove At-risk Sewer and Water Lines within the Whetstone Brook Channel

Overview and Objectives

There are 8,500 feet of sewer line and 4,900 feet of water line located at-risk within the floodway of the Whetstone Brook. In 2011 the sewer line broke in two places in the river channel during Tropical Storm Irene causing 300,000 gallons of untreated waste to flow into the Brook (WRC, 2014a). One of the washed out sewer lines was at a river crossing. This line was replaced, crossing the brook at the same location and height above the channel (Figure 11), but remains vulnerable to debris jams and erosion during floods. The other wash out was due to erosion of the river bank where the sewer line was buried in a road embankment. This area also remains vulnerable to erosion in future flood events.

In addition to being a public health and environmental hazard, businesses cannot function without sewer or water service. This is an expensive project that will take longer than five years to plan and execute, although, it is necessary given increasing flow and storm events and the extent of water and sewer lines in the channel.

Data Analysis and Results

There are four main areas where the sewer and water lines are in the floodway: downtown, near the Farmer’s Market, West Brattleboro Village and West Brattleboro. (See map in Appendix L.) As aging infrastructure is replaced, it presents an opportunity to relocate sewer and water to areas outside of the floodway.

The cost to move the water and sewer is dependent on a number of variables, including:



Figure 11: Sewer line crossing Whetstone Brook, 2008 before it washed out in Tropical Storm Irene.

- Size and type of pipe;
- Number and size of manholes and bury depth of the sewer line;
- Number of valves, air release valve stations, pressure releasing valve stations, fire hydrants, etc. on the water line;
- Whether there is a public right-of-way available to move the lines or will property acquisition or easements be required? Establishing new right of ways can be expensive and requires legal counsel;
- Number of existing connections;
- How difficult is it to transfer existing customers to the new water and sewer lines?
- Will gravity sewer connections now require grinder pumps at each customer? These types of infrastructure improvements on private property can be complicated;
- Water tight manholes covers (bolted and gasketed lids) could be added, but this requires locating the air vents outside the floodplain;
- Number of stream crossings or bridge crossings;
- Can the new sewer be constructed with the existing pipe in operation or will bypass pumping be required in some areas; and
- Traffic control.

Conceptual Design

A typical gravity sewer main with eight inch plastic pipe would cost around \$200 to \$300 per linear foot (includes pipe, excavation, manholes and reasonable surface restoration). Estimated costs for 8,500 feet of sewer in the floodway range between \$1.7 million and \$2.5 million. Installation of a typical eight inch ductile iron water line will cost around \$100 to \$150 per linear foot (includes pipe, excavation, and reasonable surface restoration). Estimated costs for 4,900 feet of water line in the floodway range between \$500,000 and \$750,000. The costs for all the other ancillary items listed can increase costs. The Vermont Department of Environmental Conservation (DEC) offers grants and loans to design and finish water and wastewater improvement projects. Hazard Mitigation Grant Program (HMGP) funding should be considered as well.

Steps for Project Implementation

Municipal officials should closely examine each of the four sections of sewer line and identify alternative locations for the pipe outside of the floodway. A full engineering evaluation should be completed to estimate the cost of flood proofing the system in place versus relocating it out of the channel. A priority ranking system could be used to phase-in upgrades over time based on risk assessment, age of infrastructure and cost.

Project Benefits

The implementation of this project would improve the flood reliability of the water and sewer service to more than 125 businesses and 700 employees and avoid the negative health and environmental impact of a ruptured sewer line.

Conserve Eight Acres of Floodplain Upstream of Downtown

Overview and Objectives

There are 43.6 acres of floodplain in the downtown and all but 10 acres are developed. The eight acres located south of the river along Williams Street were accessed by floodwaters during Tropical Storm Irene when the upstream **berm** was breached and a new channel was formed (Figure 12). The remaining two acres are upstream of Elm Street and are accessed more often during flood events. The protection of existing floodplain not only allows for the storage of flood water and sediment, but it will also prevent development of more impervious surface that will increase the likelihood of downstream flooding.

Tropical Storm Irene caused minor damages to eight buildings and major damages to three buildings, including four businesses, in the immediate area. These businesses employ approximately 52 people. Additionally, the road was damaged and the sidewalk was destroyed in this area. Allowing these eight acres to be developed will worsen local flood risks. Conserving it and potentially reducing the elevation by excavating the floodplain to increase floodwater access will reduce local flood elevations, provide for flood water and sediment storage and dissipate erosive energy from within the channel. Additional benefits include providing an area for natural storage of woody debris and ice during flood events, keeping such material out of the downtown area.

Data Analysis and Results

Using the FEMA Flood Insurance Study from 2007, the team plotted the cross sections at T and U respectively shown in Figure 14 above and found in Appendix M. The river has cut down in this area and therefore does not access the floodplain during the channel forming flow. If the floodplain was excavated down to the 10 year flood elevation (approximately 6 feet of cut) it would reduce local flood elevations during major storm events by four to five feet. Additionally the eight acres of floodplain will store 40 acre feet of water during 100 year floods, reducing the volume of water in the channel and reducing its erosive force downstream. There will also be some upstream flood reduction with the creation of floodplain in this area. A hydrologic and hydraulic analysis is required to understand the full up and downstream benefits of the project.

Conceptual Design

To provide floodplain access at the 10 year flood interval would require excavating six feet of material over eight acres. This would be expensive (\$620,000 plus \$100,000 for design, permitting, project and bid oversight) and logistically challenging. A less expensive alternative would be to remove the recently replaced berm at the upstream end of the property and allow the river to

reclaim the floodplain on its own over time. The cost of conserving the property would likely be greater than \$200,000. Ecosystem Restoration funds have been available in the past for similar types of projects.

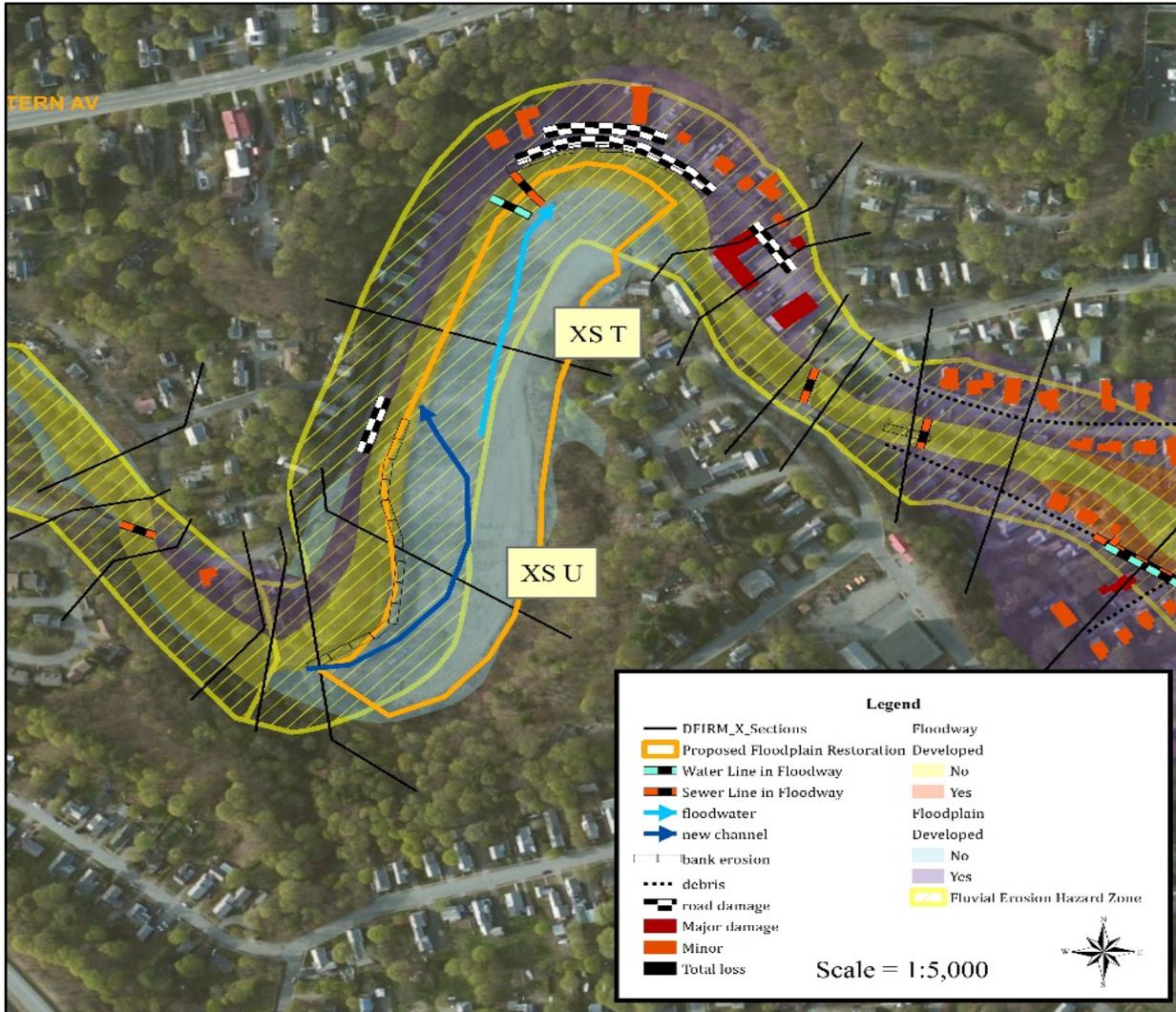


Figure 12: Eight acres of floodplain upstream of downtown

Steps for Project Implementation

Landowner outreach, to see if the property is still on the market, would be the first step to move this project forward. Coordinated outreach efforts are critical to ensuring that multiple entities are not approaching the land owner or working at cross purposes. If this is a priority project for the community, a ‘point’ entity (e.g. Conservation Commission, Town Manager, Conservation District director, etc.) should be identified. If a purchase price were agreed to, the next step would be to identify sources and apply for funding. The flood storage capacity of the site should be determined to ensure that conserving this property would provide the needed capacity. If acquired, an engineer

would be hired to model both floodplain excavation and allowing the river to reclaim the floodplain on its own. If the excavation option is chosen, all necessary state and federal permits would be required, including additional assessment of disturbance to rare, threatened, or endangered species and an archeological evaluation. An area for, or a use of, removed material would need to be located and the project put out to bid and implementation overseen.

Project Benefits

The implementation of this project is anticipated to provide benefits for reducing flood risks in Brattleboro.

Undertaking no action at this site will likely result over the long term in consequences very similar to what happened during Irene — erosion and closure of the adjacent road and damages to nearby businesses and residences. The upstream berm being enlarged and reinforced following Tropical Storm Irene may increase downstream erosion along the road and lead to the road and sewer line washing out.

Next Steps

On April 23, 2015 the team hosted the second community forum to share the list of policy and project recommendations to decrease flood risk for Brattleboro. At the forum, community members asked questions, provided input and helped rank the proposed list of priority recommendations.

The site specific projects which the community most supported included conserving the eight acre parcel just upstream from downtown, and removing the sediment plug under the Williams Street Bridge. Buyouts of at-risk properties also ranked high. Participants noted that the recommendation to straighten channels in an effort to solve alignment issues at the Route 9 Bridge (B51, near Cumberland Farms) could increase the energy of the river. While true, the lens of this study was to develop recommendations protect existing infrastructure and the local economy.

The policy and program recommendations which the community most supported included regulating new development in both the flood hazard area and in fluvial erosion hazard areas. Participants also supported continued and increased participation in FEMA's Community Rating System to reduce flood insurance rates.

The town-wide policy and program recommendations and site specific projects recommendations (Appendices D and G) provide a comprehensive list of recommended projects for the community to further discuss, explore, and advance as resources permit. The conceptual designs presented above and in Appendix J are intended to provide examples for how to advance high priority projects to the next level and acquire funding for final design and implementation. As part of the ongoing community discussion regarding the VERI effort, the team recommends the following steps to incorporate the community's input into the final prioritization and advance the projects over time:

- Solicit input from individuals and businesses at future community meetings regarding specific projects and overall project prioritization;
- Prioritize one to two projects to pursue each year with assistance from DEC and WRC staff to identify appropriate funding sources and partners;
- Apply for one to two grants each year to advance project development and/or designs;
- Implement projects as funding allows; and
- Monitor project success.

The Town of Brattleboro is now involved in a number of efforts that directly address some of the policy and program recommendations and site specific projects outlined in this report. The Town is participating in the EPA's Smart Growth Implementation Assistance program, which focuses on the Whetstone Brook corridor from Main Street upstream to near West Street. This is a mixed-use, walkable community adjacent to downtown.

The program will look at how the neighborhood can be made more resilient through techniques such as open space that also functions as flood storage or flood control, rehabbing existing

structures to make them more flood resilient, and encouraging re-development that takes into consideration both smart growth principles and flood resiliency. As part of these efforts, the Town is taking a closer look at what can be done with the eight acre parcel off Williams Street, which is another of VERI's high priority projects.

Other efforts the Town is undertaking include working on a higher rating for FEMA's Community Rating System. This is one of the top VERI policy and program recommendations. The Town will also be doing a downtown master plan, a component of which will look at ways to strengthen community interaction with both the Whetstone Brook and the Connecticut River. Having a better understanding and appreciation of these waterways can improve awareness of flooding issues, and help support the education and outreach initiatives outlined in this report. Addressing the issue of sewer lines in the floodplain is one of VERI's high priority projects. The Town is looking to receive technical advice on the sewer line, including floodproofing.

The state is advancing a project to improve public safety in and around Brattleboro by closing the barracks in Brattleboro and Rockingham and consolidating all the troopers in the single building in Westminster.

Brattleboro, its businesses and homeowners are not alone in implementing the recommendations outlined in this report. For example, the WRC can help gather and review sample bylaws, capital plans and hazard mitigation plans and help draft town specific language for review and local adoption. DHCD's Municipal Planning Grants http://accd.vermont.gov/strong_communities/opportunities/funding/overview/municipal_planning_grants, the Vermont Rivers Program <http://www.anr.state.vt.us/dec/waterq/rivers.htm> and www.floodready.vermont.gov can help support these efforts. The Vermont Land Trust <http://www.vlt.org/> can assist landowner's protection of critical floodplain with easements. The State's Hazard Mitigation Grant Program <http://vem.vermont.gov/mitigation> can help implement projects within Brattleboro's HMP. The Vermont Small Business Development Center <http://www.vtsbdc.org/> has offered extensive disaster assistance to businesses as well as compiling a great guide for owners to navigate these programs. And several federal and state programs can assist in funding the recommendations outlined in the report. Working together we can reduce the risk and financial burden of future flooding events.

Education and Outreach

Vermont has a long tradition of managing its rivers to limit or prevent flood damage including armoring riverbanks with rocks, moving or straightening river channels and building dams and berms. Despite these efforts, flooding is the most common natural disaster in Vermont (ANR). Tropical Storm Irene showed Vermonters that rivers and streams are powerful and tend to make their own way during a flood. Because we cannot reliably control flooding, educating citizens, business and property owners about rivers and potential flood risks within their communities is critical.

Ongoing community education and outreach is an important part of any effort to promote flood safety and to protect local business and economies. Ultimately, the better informed everyone in the community is about the behavior of local rivers and streams, the more likely it is that they will make sound decisions.

Make Information Readily Available: Easy access to river and floodplain information is an essential way to help citizens and businesses incorporate flood risks into the decisions they make. Most communities offer printed information at the town office or library as well as on town webpages.

“We all have short memories when it comes to flooding. It’s just human nature to think it couldn’t happen here again anytime soon.”

Chris Company, Executive Director
Windham Regional Commission

Common Handouts or Webpage Information Includes:

- Maps of the local flood hazard areas and the permitting requirements in the floodplain;
- Information about flood insurance and flood proofing buildings;
- Information about how rivers, streams and watersheds work; and
- Benefits of green infrastructure and conservation of existing floodplain.

Actively Engage: Many communities work to increase the understanding of rivers and risks via email or by posting information on their local Front Porch Forum. Communities often include flood maps and permitting information in their town meeting reports and other municipal mailings like sewer and water bills. Others promote awareness of flood history and risk by placing high water lines on prominent buildings in the community.

However, education and outreach efforts should not be the sole responsibility of local governments. Community groups like chambers of commerce, downtown business associations, neighborhood groups, and watershed organizations are encouraged to partner with state, regional and local groups to offer local workshops and education sessions.

Potential Workshop Topics, Partners or Presenters:

- Flood Insurance and What You Need to Know (Department of Finance Regulation, Division of Emergency Management and Homeland Security, Vermont League of Cities and Towns)
- Developing a Continuity of Operations Plan (Small Business Development Centers, Regional Planning Commissions, Regional Development Corporations)
- Resilient Road Designs to Reduce Recurring Damage and Improve Water Quality (Agency of Natural Resources, Agency of Transportation)
- Planning for Resilience (Regional Planning Commissions)
- Flood Risk, Preparedness and Safety (Division of Emergency Management and Homeland Security, Regional Planning Commissions)

- Extreme Weather and Climate Change (Agency of Natural Resources, Vermont Natural Resources Council)
- How Rivers, Streams and Watersheds Work (Agency of Natural Resources, Vermont Natural Resources Council, Vermont Land Trust)
- Low Cost Techniques to Reduce Flooding and Improve Water Quality (Agency of Natural Resources, Vermont Natural Resources, Regional Planning Commissions, Vermont League of Cities and Towns)

Invest in Staff Training and Certification: In many of Vermont’s cities and towns, floodplain management is just one of many responsibilities of the local planning office or zoning administrator. Yet, administration of a floodplain ordinance is quite complex and the consequences of limited staff time and understanding of the regulations can easily allow inappropriate development in dangerous areas. The consequences of granting improper variances and not enforcing against violations may preclude the community from participating in the federal flood insurance program. Therefore, local government officials are strongly encouraged to support staff training and certification in floodplain management.

What Can Individuals Do to Reduce Their Risks?

Most of us remember to annually change the batteries in our smoke alarms to reduce the risk of fire, but few of us prepare for floods or disasters. Vermont has had two or more federally-declared disasters every year since 2000, and floods have occurred nearly everywhere in the state (ANR, 2015). Buildings located in a 100-year floodplain have a 1% chance of being flooded every year. Over a 30 year period (length of most home mortgages), there is a 26% chance of a 100-year flood (USGS, 2010).

The good news is that there are many steps that individuals can take to reduce the risks, loss, disruption and costs associated with flooding. Understanding what the risks of flooding are for your home and family will help you. It is recommended that you:

- Make sure that you have the right amount of insurance coverage;
- Protect your home and take steps to limit potential damage;
- Prepare plans detailing how your family will respond if flooding looks likely; and
- Practice so family members know what actions to take in the event of a flood or upon receiving a flood warning.

Steps to Reduce Risks

- **Identify Flood Risk.** The first step is to identify your risk so you can plan appropriately. Floodplain maps are available at most town offices or click this link http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your home or apartment is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.

- **Review Insurance Policies.** While homeowners' or renters' insurance helps pay to repair or rebuild your home and replace personal property due to a covered loss, it does not cover any damages caused by floods or your rent and living expenses while your home is rebuilt. All insurance policies have overall policy limits and specific limits for different types of coverage. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage.
- **Fill Gaps in Your Insurance Coverage.** If your home is underinsured at the time of a loss, there is frequently a penalty or reduction in the amount the insurance company will pay for the loss. Property insurance does not cover flood damages or your expenses if you cannot live in your home due to flood damages. All homeowners who live in flood-prone areas should carry flood insurance. Flood insurance is available for your home and personal property and can be obtained from your local agent.
- **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about building and construction techniques that can both reduce risks and save money. Examples of the various approaches to reduce flooding in buildings are available here http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf
- **Plan Ahead.** Draft an emergency response and communications plan (including family phone numbers) for your home and family. Use the process as an opportunity to bring family members together to discuss the roles needed during an emergency and how best to assign responsibilities. Make sure you have a designated place to meet other family members in the event of an emergency. Also, don't forget to plan for individuals with special needs like prescription medication and for your pets as many public shelters or hotels do not allow animals.
 - Pack an emergency kit and make sure family members know where it is located.
 - Keep copies of your insurance policy, computer data and other important documents like tax returns and financial information safe from flooding on upper floors or stored offsite.
 - Document your home and possessions with photos or video to help simplify the insurance claims process. Generally, the more detailed documentation (receipts, serial numbers, etc.) you can supply during the claims process, the fewer problems you will experience.
- **Train and Practice.** Many of us participate in fire drills at work or school, but few of us practice at home for disasters. Training and practicing your emergency response and communications plan will help assure the plan is workable and family members understand their roles and responsibilities.

- **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. If you know a storm is headed your way, fill up your gas tank in case you must evacuate. (If the power is out, it is not always easy to find an operating gas station.) If you must evacuate, try to contact your employer and let them know your plans. Having a plan and a few extra minutes to evacuate can make a difference.

FEMA <http://www.ready.gov/make-a-plan> and the Vermont Division of Emergency Management and Homeland Security <http://vem.vermont.gov/preparedness/hazards/floods> both provide more detailed information on how to prepare and protect your home and family from disasters and floods.

What Can Businesses Do to Reduce Their Risks?

According to FEMA, nearly 40% of businesses do not reopen after a disaster and data from the US Small Business Administration indicates that over 90% of businesses fail within two years after being struck by a disaster.

It can take years to repair the damage to the building, furnishings, equipment and inventory. Disasters can also require businesses to relocate or cease operation temporarily, which may lead to canceled contracts and customers going elsewhere for goods or services. Even if the event does not impact the business directly, severe weather from snow or rain or even extended power outages can strand employees at home and complicate deliveries.

Identifying your risk can significantly reduce potential damages and business recovery costs. Understanding what the risks of flooding are for your business will help you:

- Make sure that you have the right insurance coverage for business interruption;
- Plan ahead and take steps like developing a continuity of operations plan to limit potential damage; and
- Train employees so they know what actions to take in the event of a disaster or after receiving a flood warning.

Steps to Reduce Risks

- **Identify Flood Risk.** Vermont has had two or more federally-declared disasters every year since 2000 and floods have occurred nearly everywhere in the state (ANR). Identifying your risk is a good place to start. Floodplain maps are available at most town offices or click here http://floodready.vermont.gov/assessment/vt_floodready_atlas to find out if your business is in an area where floods could potentially happen. Once you have assessed your flood risk, review your insurance coverage.
- **Review Insurance Policies.** Many types of disasters are not covered under normal insurance policies and funding or loans from government agencies is often too little and too

late. All insurance policies have overall policy limits and specific limits for different types of coverage. Any business located in a flood-prone area should carry flood insurance. Also check to make sure your insurance includes business interruption coverage and that it reimburses other unexpected costs (like service interruptions from lost power or Internet access, law suits and unemployment compensation claims filed by employees). Business interruption insurance compensates a business for lost income, expenses and profits if a disaster, such as a flood, closes your doors. Your insurance agent can help you determine what is covered and what is excluded and check to make sure your coverage is adequate for your needs. However, insurance is complicated and it's a good idea to have your lawyer review your policy, consider various scenarios and help you identify any gaps in your insurance coverage.

- **Floodproof and Elevate Utilities.** The cost of flood insurance may be reduced with building modifications. Contact your planning and zoning office to learn more about building and construction techniques that can both reduce risks and save money. Examples of the various approaches to reduce flooding in buildings are available here http://accd.vermont.gov/sites/accd/files/Flood_Mitigation_Case_Studies_Final.pdf
- **Plan Ahead.** There are also a number of low-cost steps you can take to reduce the impacts of a flood. At a minimum, regularly back up computer data and store important tax and financial records and information such as your insurance policy details in a flood safe place. Documenting your building, furnishings, equipment and inventory with photos or video can speed the insurance claims process.

All businesses should have a continuity of operations plan. A continuity of operations plan is a written document that outlines how your business will respond and recover from a flood or other disaster. At a minimum, your plan should include:

- A list of important contacts including your insurance company, key customers and vendors and evacuation contacts for staff.
- A map showing locations of important equipment to relocate (computers and servers) and where to shut off electricity, gas and other services.
- Procedures to protect your property and minimize business disruption – e.g. remote back up of computer files, a plan to relocate inventory or livestock.
- A back up location to conduct business while the building is being repaired.

Having a continuity of operations plan will help you identify and assign essential tasks that will help minimize the damage caused by flooding. Training and practice will help assure the plan is workable and employees are properly trained.

The Vermont Small Business Development Center <http://www.vtsbdc.org> and many of Vermont's Regional Development Corporations <http://accd.vermont.gov/business/partners/rdc> and Regional Planning Commissions

<http://www.vapda.org> can also provide training and one-on-one assistance to help your business develop a continuity of operations plan.

CERF+ (Craft Emergency Relief Fund + Artists' Emergency Resources) offers tailored disaster guidance and recourses for artists

(<http://studioprotector.org/OnlineGuide/DisasterPlanning/DisasterSpecificPlanningResources.aspx>).

- **Train and Practice.** Employees need to understand flood warnings and what to do when they get one. This includes understanding the dangers of flooding and how to evacuate the building safely. Train all staff on procedures to shut down the business and how to deploy loss reduction measures like relocating equipment and inventory to upper floors and deploying door and window dams to reduce flooding. Finally, remember that flooding can also affect employees' ability to work, as their priority may be to protect their home and family first.
- **Pay Attention to Emergency Alerts.** Listen to local news and weather reports for any potential flood warnings in your area. Having a continuity of operations plan and a few extra minutes to evacuate can save lives and your business.

The US Small Business Administration <https://www.sba.gov/content/disaster-preparedness> offers more detailed information on how to prepare and protect your employees and business and from disasters and floods.

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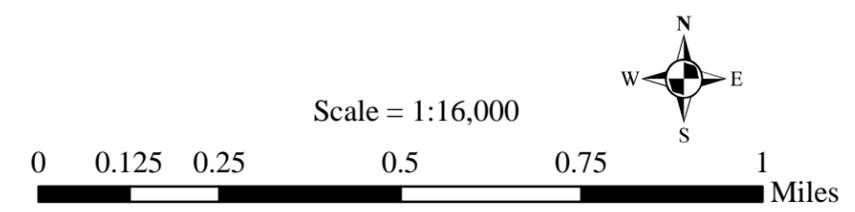
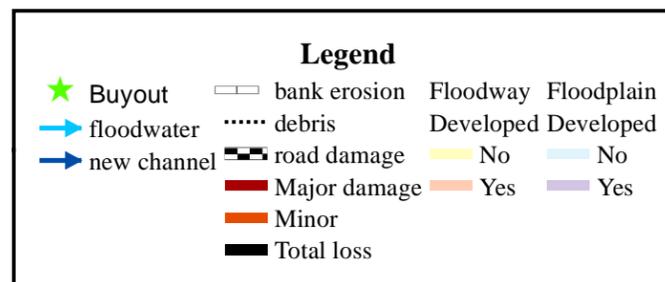
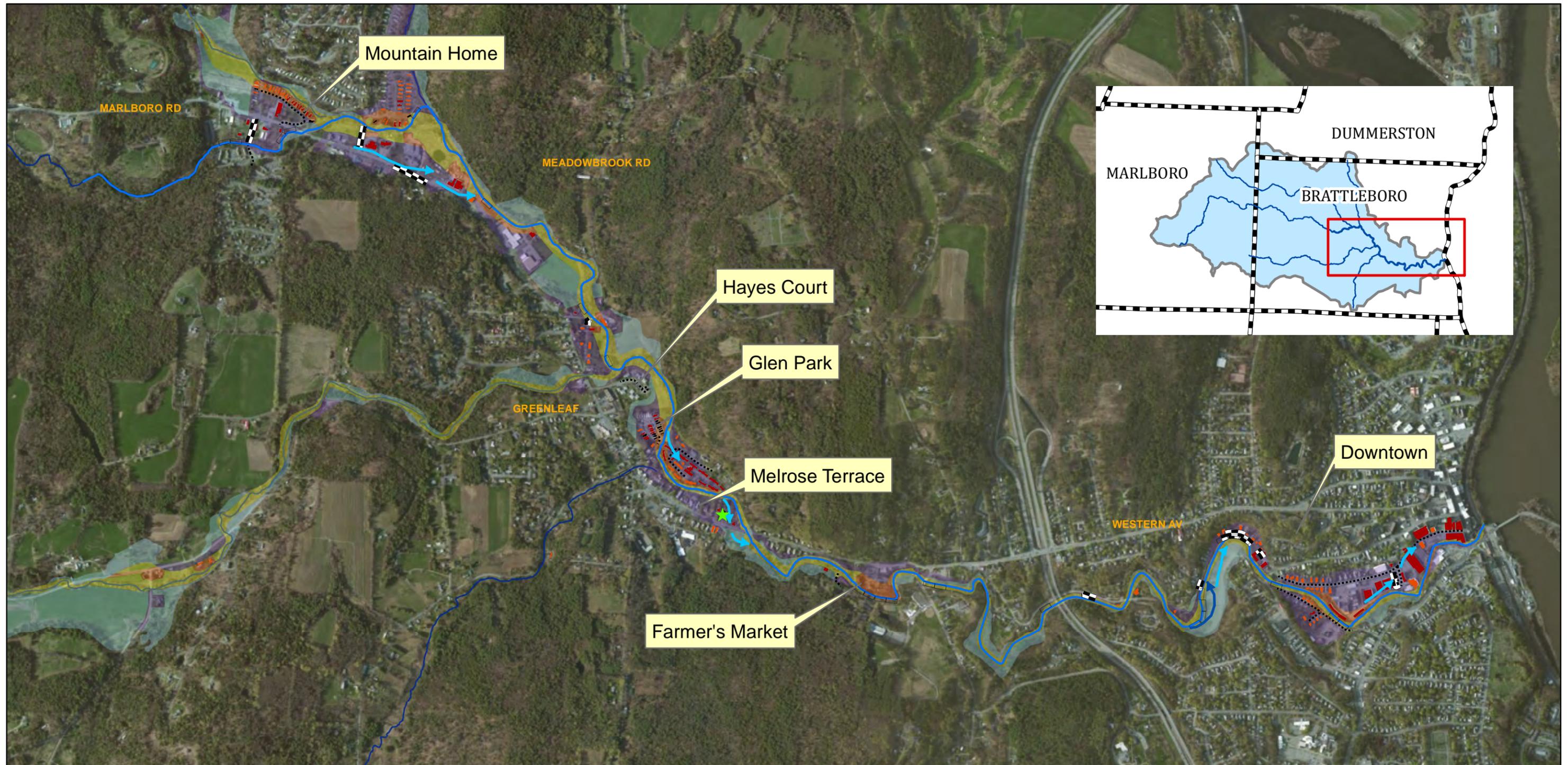
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Appendix A:
Town of Brattleboro and Whetstone Brook Data
Sources

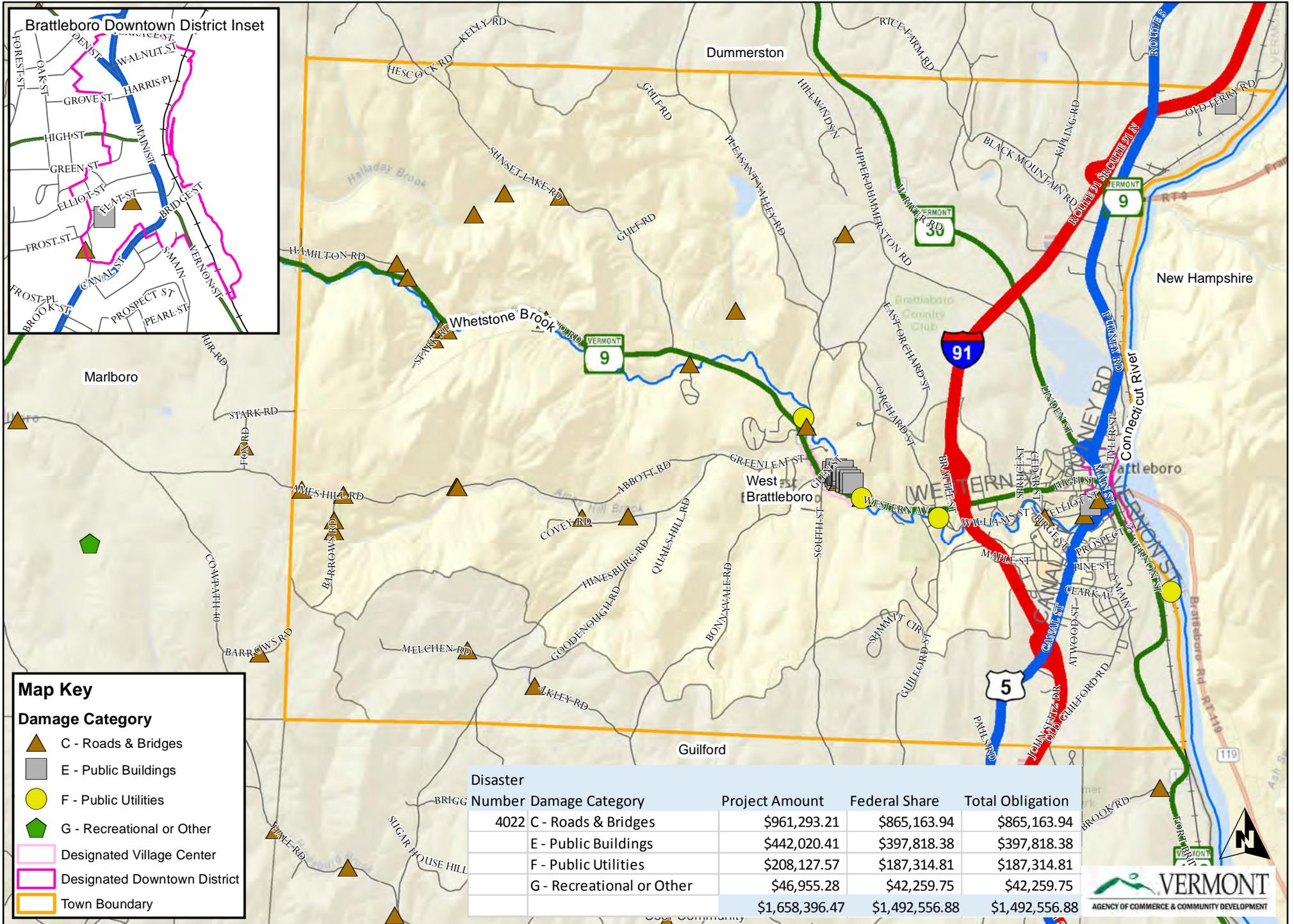
Name	Description	Source
Licensed Businesses	Mapping of licensed businesses throughout Brattleboro.	Town Of Brattleboro
Fluvial Erosion Hazard Zone (FEH) & Interim Ordinance	River corridor most likely to erode to accommodate a stable channel planform.	VANR; Town of Brattleboro
USGS topographic maps	Current and historic topographic mapping of Brattleboro. 1893, 1935, 1954 and circa 1980's.	USGS
Whetstone Brook Geomorphic Assessment and River Corridor Plan	Data and maps of channel stability and aquatic habitat, and recommended actions to improve river stability and reduce flood hazards.	LNRP 2008; Vermont Agency of Natural Resources (VANR)
Flood Insurance Study	Basis for Flood Insurance Rate flood insurance and floodplain management applications.	FEMA, 2007
FEMA Floodplain and Floodway	Digital mapping of Floodway, 100-year and 500 year floodplain.	VANR/VCGI
Vermont River Corridor	State-mapped erosion hazard area where river is most likely to be located.	VANR, 2008
EPA Flood Resiliency Checklist	This checklist can help communities identify opportunities to improve their resilience to future floods through policy and regulatory tools.	EPA, July, 2014
Completed Resiliency Projects	Information about completed projects and flood resiliency efforts initiated by the Town	Windham County Natural Resource Conservation District
Repeat Damage Maps	Mapping of repeat damage sites associated with FEMA-declared disasters	Vermont Agency of Commerce and Community Development (ACCD), FEMA
Aerial photographs	Current aerial photographs	Various sources accessed through ESRI ArcMap 10.0
Brattleboro Town Plan	Vision for Brattleboro	2013 Town of Brattleboro
Photographs	Miscellaneous photographs of project area	LNRP 2008, 2014

Appendix B:
**Tropical Storm Irene Damages and Developed
Floodplain Map**

Tropical Storm Irene Damages & Developed Floodplain Brattleboro, VT Vermont Economic Resiliency Initiative (VERI)



Whetstone Brook, Brattleboro, VT



Appendix C:

V-DAT One-page Visual Summary of the Top Recommendations for Brattleboro

Brattleboro, VT Conceptual Vision for Our Community

Brattleboro is one of the larger communities in Vermont with a population of 12,500. The community is a "gateway" to Vermont from Massachusetts and a crossroads connecting New Hampshire, Massachusetts, and Vermont. Downtown Brattleboro is a vibrant community. Although not a city, Brattleboro feels more "urban" than most other Vermont communities with three and four story buildings, bustling street traffic, and an abundance of shops and restaurants, cultural amenities, and civic institutions.

Often cited as a livable community and resembling a college town, Brattleboro is home to several significant downtown attractions including one of the largest Co-op markets in the state, the Latchis Theatre and Hotel, The Robert H Gibson River Garden and the Brattleboro Museum and Art Center.

While the community is located along the Connecticut River, downtown has only a few direct connections to the water. Whetstone Brook passes through downtown Brattleboro and is a scenic yet underutilized asset.

Catastrophic Events

Brattleboro has suffered from a number of events over the past several years that have negatively impacted the community. Spring floods in 2011 flooded West Brattleboro and a large fire gutted the Brooks House in 2012, a prominent mixed-use building on the 100% corner of downtown. The fire took out numerous residential units and retail locations in a prime location. Tropical Storm Irene flooded many businesses along Flat Street and caused major damage to the Latchis in 2011.

Recovery

To date, much has happened in Brattleboro to recover. The Brooks House will become home to the Community College of Vermont, which will bring students into the heart of downtown. The Latchis Hotel and Theater has reopened and has unveiled renovations to its art deco main theatre. A new restaurant has opened along the Connecticut River, and the Co-op has significantly expanded. Plans are underway for a significant creative economy space in downtown. The Town has also deployed wayfinding signs directing visitors from the Interstate into downtown.

V-DAT

The Vermont Downtown Action Team (V-DAT) was selected by the State of Vermont, Department of Housing and Community Development, Vermont Downtown Program in May 2013 to conduct a community planning and economic development charrette in Brattleboro. The V-DAT was comprised of experts in architecture, planning, landscape architecture, historic preservation, economic development, organizational structure, landscape architecture, engineering and community branding.

The V-DAT planning charrette operates on three key tenants: utilizing an asset based approach, addressing the community in a holistic manner, and conducting the exercise in a public forum.



Building Rehabilitation

Downtown Brattleboro has excellent building stock and wonderful architecture. Many of the buildings in downtown have been renovated and the Brooks House renovation will bring one of the most important structures in downtown back to its former glory. While in Brattleboro, the V-DAT Team was able to meet with property owners interested in rehabilitating or renovating their own buildings. The illustrations above show before and after renderings of the Market Block and the Brattleboro Bicycle Shop. These renderings are designed to provide guidance to property owners as they make improvements or seek financing for more comprehensive rehabilitation.



Project Funding and Support

This project was supported by funding from the U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant - Disaster Recovery. The plan was prepared as a cooperative effort of the State of Vermont Department of Housing and Community Development, the Division of Community Planning and Revitalization and the Town of Brattleboro. The contents of this document do not necessarily reflect the official views or policy of HUD or the State of Vermont. For more information on the Vermont Downtown Action Team (V-DAT) program and links to the detailed presentation and report for Brattleboro please visit http://accd.vermont.gov/strong_communities/opportunities/revitalization/vdat or call (802) 828-5229.



Illustrative Master Plan

The plan for Downtown Brattleboro outlines public realm improvements, parking improvements, private sector investments, infill opportunities, and enhanced connections throughout downtown.



Whetstone Brook

The Whetstone Brook is a tremendous but underutilized asset through the heart of downtown. Rock outcrops, rapids and building foundations combine to create memorable views throughout the brook corridor, particularly between the pedestrian bridge and the outfall at the Connecticut River. There are several opportunities to celebrate the Whetstone and provide more opportunities for residents and visitors to experience it as a destination or while conducting daily business around it. These areas include the edges west of the Main Street Bridge, the area along Bridge Street south of the Main Street Bridge and along the railroad right-of-way and future trail connection. With simple improvements such as clearing vegetation, removing utilitarian fences, lighting, and art this space can emerge as a focal point in downtown.



River Overlook

Brattleboro benefits from dramatic views to the Connecticut River. However, in many instances like this one, significant undergrowth prevents clear views to the river and the spaces that could accommodate viewing areas have not been designed to enhance that viewing experience.

Waterfront Area

Downtown Brattleboro is located at a wide point in the Connecticut River, affording dramatic views of the river valley to the north and south. Currently, however, the waterfront area does not capitalize on river, with the exception of the Whetstone Station Restaurant and Brewery. Once the bridge at Bridge Street is converted to a pedestrian and bicycle bridge, this area could be enhanced as a significant open space amenity and gateway to downtown. Additionally, the waterfront could offer a memorable gateway for visitors arriving by train.



Appendix D:
Tables of Projects to Protect Brattleboro

Recommended Projects to Protect Businesses and Infrastructure from Flooding

Brattleboro, VT
 Vermont Economic Resiliency Initiative (VERI)
 January, 2015

Legend					
	Effective		Limited		Ineffective

* Priority rating based on objectives and potential business impact

Project	What is At Risk?	Potential Business Impacts	Priority*	OBJECTIVES			FEASIBILITY			Comments
				Reduces Flood Risk ¹	Reduces Erosion Risk ²	Protects Businesses, Infrastructure, and Property	Ease of Implementation	Cost Range	Estimated Time for Implementation	
Building and Site Improvements										
Continue to flood proof downtown buildings (see site 17)	Businesses and residences	>60 businesses and 500 employees	Medium				Moderate	<\$10K per building	1-2 years	The downtown has 114 buildings in the floodplain; 10 in the floodway, three of those severely damaged during Tropical Storm Irene; 18 buildings with major damage in the downtown and 29 with minor damage during Tropical Storm Irene. There is a pending project to upgrade the storm water collection in this area.
Flood proof existing buildings in the floodplain (see site 11)	Businesses and residences	Seven town licensed businesses and Melrose Terrace	Low				Moderate	<\$10K per building	1-2 years	This reach has 91 buildings in the floodplain 12 of which are in the Floodway; 12 are recorded as a total loss after T.S. Irene; 21 had 'major damage' from Tropical Storm Irene; and nine had 'minor' damage from TS Irene for a total of 42 damaged properties in this reach.
Flood proof buildings (see site 7)	Businesses	> 23 town licensed businesses and 100 employees	Low				Moderate	<\$10K per building	1-2 years	This area has 61 buildings in the floodplain; 10 in the floodway; two mobile homes were total losses; 11 buildings had major damage; 15 had minor damage.
Flood proof buildings (see site 3)	Businesses	7 town licensed businesses and 30 employees	Low				Moderate	<\$10K per building	1-2 years	This area has 34 units in the floodplain; 23 in the Floodway; three total losses; nine with major damage; 11 with minor damage.
Channel and Floodplain Management										
Adopt Town Zoning to prohibit new development in fluvial erosion hazard zone and 100 year flood inundation zone	Future business and residential buildings	>125 businesses and 700 employees	High				Difficult	\$10K-\$50K	2-5 years	Protect existing businesses by maintaining flood storage capacity and eliminate damage to future business and residential development by not building in the areas most prone to flood and erosion risk.
Conserve 8 acres of floodplain, upstream of the downtown, accessed during Tropical Storm Irene and remove berm (see site 16)	Downtown businesses and residents	>60 businesses and 500 employees	High				Moderate	>\$200K	2-5 years	There are 43.6 acres of mapped floodplain downtown, 33.6 of which are developed. The remaining ten, on two sites, are locally significant for flood storage that will reduce risks to downstream businesses. This was project #8 in the River Corridor Plan.

¹Reduces Flood Risk - The proposed project/strategy lowers the flood level.

²Reduces Erosion Risk - The proposed project/strategy lessens the vulnerability of a location to erosion.

Recommended Projects to Protect Businesses and Infrastructure from Flooding

Brattleboro, VT
Vermont Economic Resiliency Initiative (VERI)
January, 2015

Legend					
	Effective		Limited		Ineffective

* Priority rating based on objectives and potential business impact

Project	What is At Risk?	Potential Business Impacts	Priority*	OBJECTIVES			FEASIBILITY			Comments
				Reduces Flood Risk ¹	Reduces Erosion Risk ²	Protects Businesses, Infrastructure, and Property	Ease of Implementation	Cost Range	Estimated Time for Implementation	
Preserve existing undeveloped wetland corridor (see site 1)	West Brattleboro businesses and public safety (police)	VT State Police Barracks; three businesses and Westgate Apartments	Medium				Easy	\$10K-\$50K	1-2 years	Upstream flood storage capacity is critical in the Whetstone Watershed. Not only does this area provide storage for flood waters as they come off the mountain, it also captures large amounts of woody debris, preventing it from causing debris jams downstream. This project was identified in the River Corridor Plan.
Assist Farmer's Market with relocating, conserve parcel and remove berm; stabilize erosion on south bank (see site 12)	Businesses and residences	Farmer's Market; Evergreen Condos; Guilford Road Bridge	Medium				Moderate	\$100K-\$200K	2-5 years	The Farmer's Market is located entirely in the floodway, and the structures are prone to washing out and causing debris jams downstream. The south bank, across from the Farmer's Market, is eroding. Moving to higher ground is the safest and least cost alternative over time and will increase flood storage capacity and reduce erosion on the south bank.
Protect remaining undeveloped floodplain (7 acres south + 5 acres north of Whetstone Brook) (see site 9)	Businesses and residences	> 10 businesses in immediate vicinity and 15 employees; Meadowbrook Road bridge	Medium				Difficult	>\$200K	2-5 years	Maintaining flood storage capacity will reduce potential damages within the reach and downstream. The remaining floodplain is locally significant for flood storage and it will reduce risks to downstream businesses.
Conserve narrow piece on south bank; improve floodplain access on Locke Field (see site 2)	Businesses	16 West Brattleboro businesses, including State Police Barracks	Medium				Easy	\$10K-\$50K	1-2 years	This small, narrow strip of land was not part of the original Locke Field conservation project although it is on the same side of the river. The berms on it inhibit floodplain access to the already conserved land.
Work with businesses to decrease impervious surfaces and install rain gardens/green infrastructure (see site 8)	Businesses	N/A	Low				Easy	\$10K-\$50K/site	1-2 years	Localized flooding during smaller storm events due to a lot of impervious surfaces. Parking lots and storage areas in this confluence area could be re-designed to provide floodplain function during rain events while still being used for parking and storage. This was priority project #6 in the River Corridor Plan.

¹Reduces Flood Risk - The proposed project/strategy lowers the flood level.

²Reduces Erosion Risk - The proposed project/strategy lessens the vulnerability of a location to erosion.

Recommended Projects to Protect Businesses and Infrastructure from Flooding

Brattleboro, VT

Vermont Economic Resiliency Initiative (VERI)

January, 2015

Legend					
	Effective		Limited		Ineffective

* Priority rating based on objectives and potential business impact

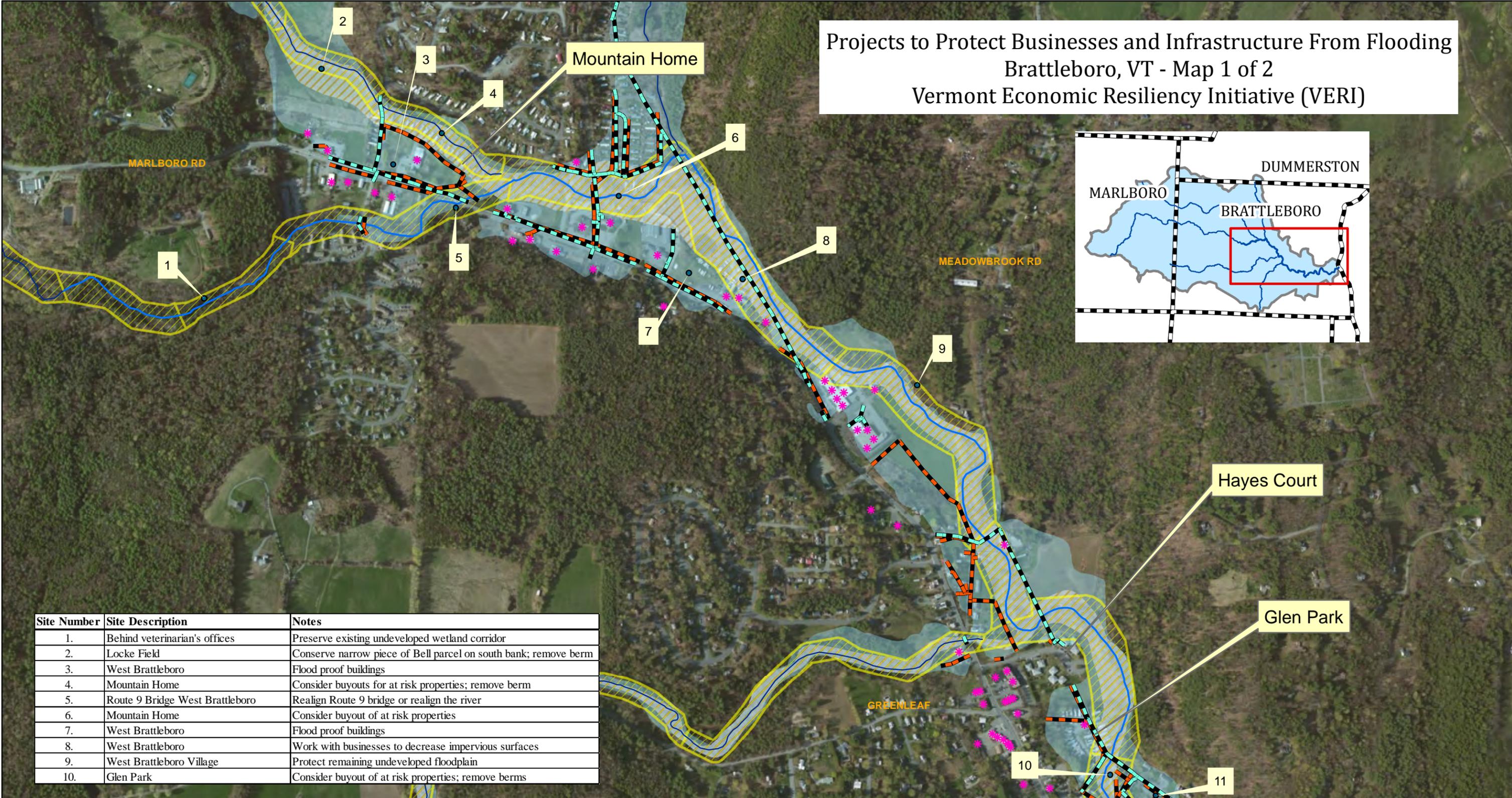
Project	What is At Risk?	Potential Business Impacts	Priority*	OBJECTIVES			FEASIBILITY			Comments
				Reduces Flood Risk ¹	Reduces Erosion Risk ²	Protects Businesses, Infrastructure, and Property	Ease of Implementation	Cost Range	Estimated Time for Implementation	
Infrastructure Improvements										
Remove channel blocking sediment upstream of the downstream Williams Street Bridge (see site 15)	Town bridge and road; secondary transportation network	>60 businesses and 500 employees	High				Easy	\$10K-\$50K	1-2 years	103' span can adequately pass bankfull+ events (67') if right channel is cleared out. The bridge was closed for a couple of weeks after scour from Tropical Storm Irene undermined the east abutment. Vermont Agency of Transportation bridge inspection on 6/19/14 also recommends removing the gravel and doing other maintenance. Bridge pier and alignment need adjustment to improve sediment transport.
Realign Route 9 bridge or realign the river (see site 5)	State highway and bridge	>30 businesses and 140 employees	High				Moderate	\$100K-\$200K	2-5 years	This bridge is misaligned and the left bank is eroding and required repair after Tropical Storm Irene. Riprapping the left bank and improving the road/river alignment will avoid future washouts.
Remove sewer and water lines within the river channel at locations throughout the project area (see site 13)	Businesses and residents of Brattleboro	>125 businesses and 700 employees	High				Difficult	>\$2.5 million	>5 years	Public health and risks to businesses require responsible location of the sanitary sewer and water lines.
Stabilize utility poles along river corridor (see site 14)	Power and communications	>125 businesses and 700 employees	Medium				Easy	\$50K-\$100K	2-5 years	Utility pole in stream channel east of I91 crossing where the road was damaged and the sewer line broke during Tropical Storm Irene.
Public Safety Improvements										
Consider buyout for at risk properties; remove berm (see site 4)	Mountain Home Mobile Home Park	Affordable housing	High				Difficult	>\$400K	>5 years	Maintaining affordable housing units in the floodway and floodplain puts the most vulnerable in harm's way.
Consider buyouts for at risk properties; remove berms (see site 10)	Glen Park Mobile Home Park	Affordable housing	High				Difficult	>\$200K	>5 years	Maintaining affordable housing units in the floodway and floodplain puts the most vulnerable in harm's way. This was priority project #5 in the corridor plan.
Consider buyouts for at risk properties (see site 6)	Mountain Home Mobile Home Park	Affordable housing	High				Difficult	\$100K-\$200K	>5 years	Maintaining affordable housing units in the floodway and floodplain puts the most vulnerable in harm's way. This was priority project #4 in the corridor plan.

¹Reduces Flood Risk - The proposed project/strategy lowers the flood level.

²Reduces Erosion Risk - The proposed project/strategy lessens the vulnerability of a location to erosion.

Appendix E:
Maps of Projects to Protect Brattleboro

Projects to Protect Businesses and Infrastructure From Flooding
 Brattleboro, VT - Map 1 of 2
 Vermont Economic Resiliency Initiative (VERI)



Site Number	Site Description	Notes
1.	Behind veterinarian's offices	Preserve existing undeveloped wetland corridor
2.	Locke Field	Conserve narrow piece of Bell parcel on south bank; remove berm
3.	West Brattleboro	Flood proof buildings
4.	Mountain Home	Consider buyouts for at risk properties; remove berm
5.	Route 9 Bridge West Brattleboro	Realign Route 9 bridge or realign the river
6.	Mountain Home	Consider buyout of at risk properties
7.	West Brattleboro	Flood proof buildings
8.	West Brattleboro	Work with businesses to decrease impervious surfaces
9.	West Brattleboro Village	Protect remaining undeveloped floodplain
10.	Glen Park	Consider buyout of at risk properties; remove berms

Legend

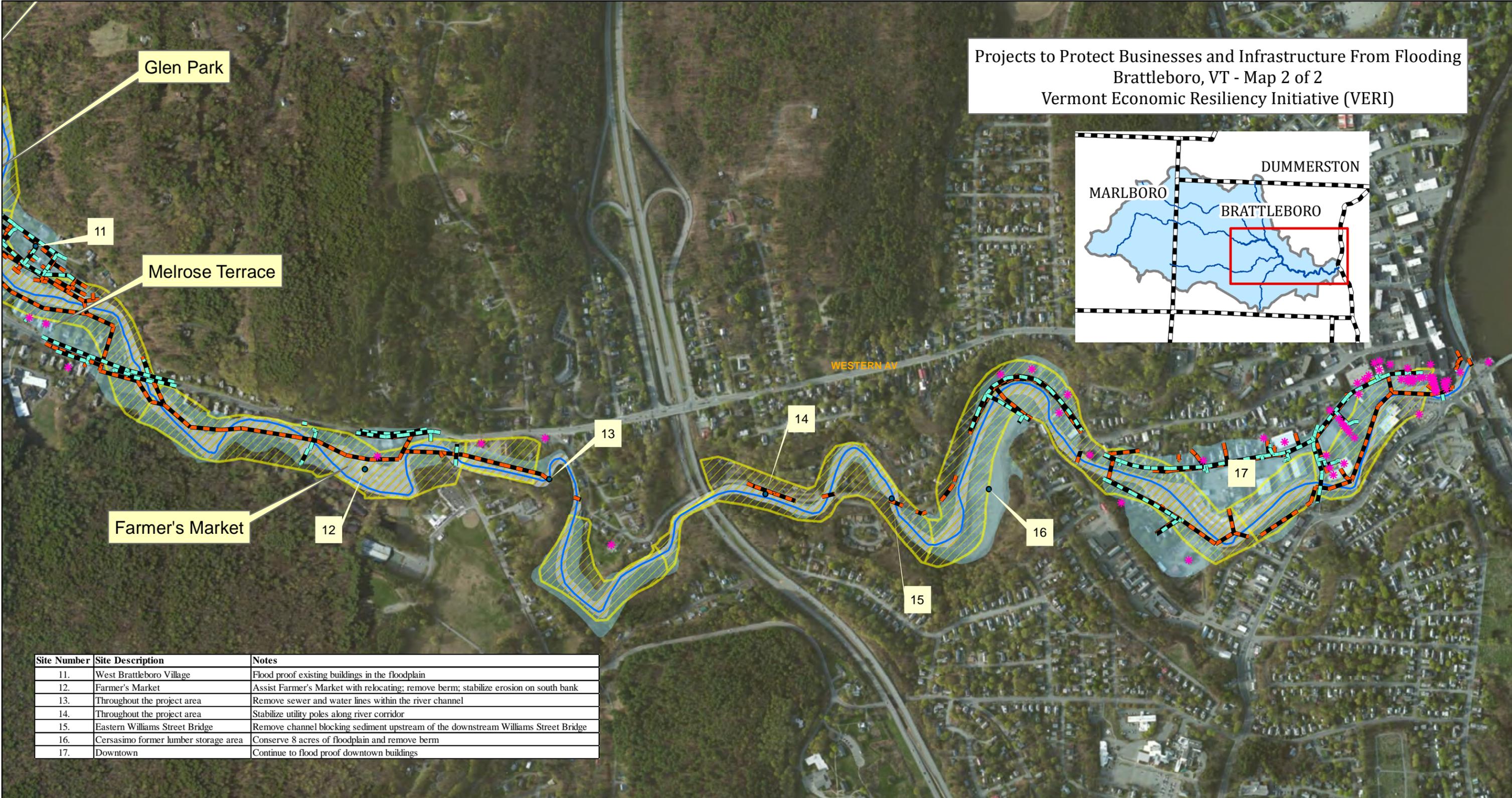
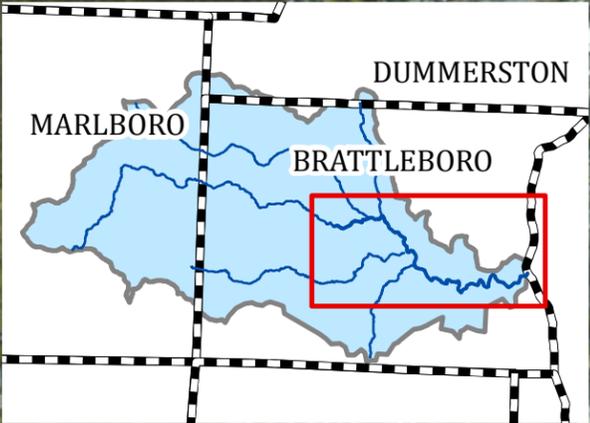
- Project Site
- * Licensed Business
- Water Line in Floodplain
- Sewer Line in Floodplain
- Fluvial Erosion Hazard Zone
- Floodway
- Floodplain

Please see Projects Table for more information.

Scale = 1" = 700'

Landslide Natural Resource Planning
 Linking people to their landscape
 P O Box 311
 East Middlebury, VT 05740
 Telephone: 802-388-9278

Projects to Protect Businesses and Infrastructure From Flooding
 Brattleboro, VT - Map 2 of 2
 Vermont Economic Resiliency Initiative (VERI)



Site Number	Site Description	Notes
11.	West Brattleboro Village	Flood proof existing buildings in the floodplain
12.	Farmer's Market	Assist Farmer's Market with relocating; remove berm; stabilize erosion on south bank
13.	Throughout the project area	Remove sewer and water lines within the river channel
14.	Throughout the project area	Stabilize utility poles along river corridor
15.	Eastern Williams Street Bridge	Remove channel blocking sediment upstream of the downstream Williams Street Bridge
16.	Cersasimo former lumber storage area	Conserve 8 acres of floodplain and remove berm
17.	Downtown	Continue to flood proof downtown buildings

Legend

- Project Site
- * Licensed Business
- Water Line in Floodplain
- Sewer Line in Floodplain
- ▨ Fluvial Erosion Hazard Zone
- ▨ Floodway
- ▨ Floodplain

Please see Projects Table for more information.

Scale = 1" = 700'

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Appendix F:
EPA Flood Resilience Checklist

Flood Resilience Checklist

Is your community prepared for a possible flood? Completing this flood resilience checklist can help you begin to answer that question. This checklist was developed as part of the U.S. Environmental Protection Agency's Smart Growth Implementation Assistance project in the state of Vermont. More information about the project can be found by reading the full report, *Planning for Flood Recovery and Long-Term Resilience in Vermont*, found online at www.epa.gov/smartgrowth/sgia_communities.htm#rec1.

What is the Flood Resilience Checklist?

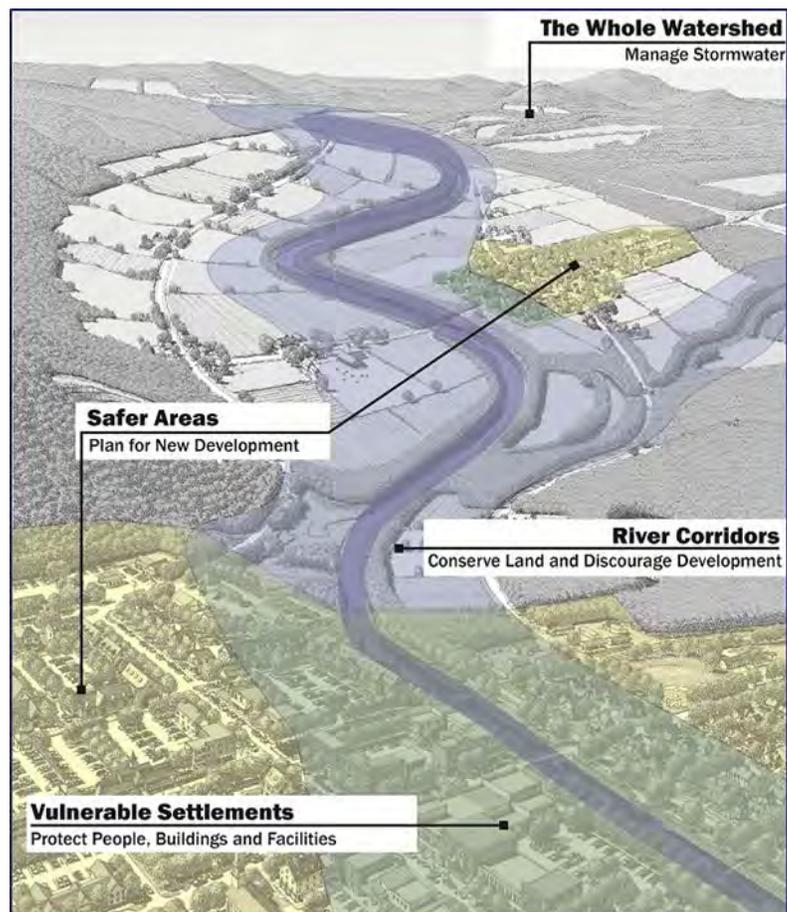
This checklist includes overall strategies to improve flood resilience as well as specific strategies to conserve land and discourage development in river corridors; to protect people, businesses, and facilities in vulnerable settlements; to direct development to safer areas; and to implement and coordinate stormwater management practices throughout the whole watershed.

Who should use it?

This checklist can help communities identify opportunities to improve their resilience to future floods through policy and regulatory tools, including comprehensive plans, Hazard Mitigation Plans, local land use codes and regulations, and non-regulatory programs implemented at the local level. Local government departments such as community planning, public works, and emergency services; elected and appointed local officials; and other community organizations and nonprofits can use the checklist to assess their community's readiness to prepare for, deal with, and recover from floods.

Why is it important?

Completing this checklist is the first step in assessing how well a community is positioned to avoid and/or reduce flood damage and to recover from floods. If a community is not yet using some of the strategies listed in the checklist and would like to, the policy options and resources listed in the [Planning for Flood Recovery and Long-Term Resilience in Vermont](#) report can provide ideas for how to begin implementing these approaches.



This graphic illustrates the four categories of approaches to enhance resilience to future floods. Credit: Vermont Agency of Commerce and Community Development.

FLOOD RESILIENCE CHECKLIST

Overall Strategies to Enhance Flood Resilience

(Learn more in Section 2, pp. 9-11 of

[Planning for Flood Recovery and Long-Term Resilience in Vermont](#))

1. Does the community's comprehensive plan have a hazard element or flood planning section?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
a. Does the comprehensive plan cross-reference the local Hazard Mitigation Plan and any disaster recovery plans?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
b. Does the comprehensive plan identify flood- and erosion-prone areas, including river corridor and fluvial erosion hazard areas, if applicable?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
c. Did the local government emergency response personnel, flood plain manager, and department of public works participate in developing/updating the comprehensive plan?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
2. Does the community have a local Hazard Mitigation Plan approved by the Federal Emergency Management Agency (FEMA) and the state emergency management agency?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
a. Does the Hazard Mitigation Plan cross-reference the local comprehensive plan?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
b. Was the local government planner or zoning administrator involved in developing/updating the Hazard Mitigation Plan?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
c. Were groups such as local businesses, schools, hospitals/medical facilities, agricultural landowners, and others who could be affected by floods involved in the Hazard Mitigation Plan drafting process?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
d. Were other local governments in the watershed involved to coordinate responses and strategies?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
e. Does the Hazard Mitigation Plan emphasize non-structural pre-disaster mitigation measures such as acquiring flood-prone lands and adopting No Adverse Impact flood plain regulations?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
f. Does the Hazard Mitigation Plan encourage using green infrastructure techniques to help prevent flooding?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
g. Does the Hazard Mitigation Plan identify projects that could be included in pre-disaster grant applications and does it expedite the application process for post-disaster Hazard Mitigation Grant Program acquisitions?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
3. Do other community plans (e.g., open space or parks plans) require or encourage green infrastructure techniques?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

FLOOD RESILIENCE CHECKLIST

4. Do all community plans consider possible impacts of climate change on areas that are likely to be flooded?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
5. Are structural flood mitigation approaches (such as repairing bridges, culverts, and levees) and non-structural approaches (such as green infrastructure) that require significant investment of resources coordinated with local capital improvement plans and prioritized in the budget?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
6. Does the community participate in the National Flood Insurance Program Community Rating System?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Conserve Land and Discourage Development in River Corridors (Learn more in Section 3.A, pp. 14-19 of Planning for Flood Recovery and Long-Term Resilience in Vermont)		
1. Has the community implemented non-regulatory strategies to conserve land in river corridors, such as:		
a. Acquisition of land (or conservation easements on land) to allow for stormwater absorption, river channel adjustment, or other flood resilience benefits?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
b. Buyouts of properties that are frequently flooded?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
c. Transfer of development rights program that targets flood-prone areas as sending areas and safer areas as receiving areas?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
d. Tax incentives for conserving vulnerable land?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
e. Incentives for restoring riparian and wetland vegetation in areas subject to erosion and flooding?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
2. Has the community encouraged agricultural and other landowners to implement pre-disaster mitigation measures, such as:		
a. Storing hay bales and equipment in areas less likely to be flooded?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
b. Installing ponds or swales to capture stormwater?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
c. Planting vegetation that can tolerate inundation?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
d. Using land management practices to improve the capability of the soil on their lands to retain water?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
3. Has the community adopted flood plain development limits that go beyond FEMA's minimum standards for Special Flood Hazard Areas and also prohibit or reduce any new encroachment and fill in river corridors and Fluvial Erosion Hazard areas?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

FLOOD RESILIENCE CHECKLIST

FLOOD RESILIENCE CHECKLIST		
4. Has the community implemented development regulations that incorporate approaches and standards to protect land in vulnerable areas, including:		
a. Fluvial erosion hazard zoning?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
b. Agricultural or open space zoning?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
c. Conservation or cluster subdivision ordinances, where appropriate?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
d. Other zoning or regulatory tools that limit development in areas subject to flooding, including river corridors and Special Flood Hazard Areas?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Protect People, Buildings, and Facilities in Vulnerable Settlements (Learn more in Section 3.B, pp. 19-26 of Planning for Flood Recovery and Long-Term Resilience in Vermont)		
1. Do the local comprehensive plan and Hazard Mitigation Plan identify developed areas that have been or are likely to be flooded?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
a. If so, does the comprehensive plan discourage development in those areas or require strategies to reduce damage to buildings during floods (such as elevating heating, ventilation, and air conditioning (HVAC) systems and flood-proofing basements)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
b. Does the Hazard Mitigation Plan identify critical facilities and infrastructure that are located in vulnerable areas and should be protected, repaired, or relocated (e.g., town facilities, bridges, roads, and wastewater facilities)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
2. Do land development regulations and building codes promote safer building and rebuilding in flood-prone areas? Specifically:		
a. Do zoning or flood plain regulations require elevation of two or more feet above base flood elevation?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
b. Does the community have the ability to establish a temporary post-disaster building moratorium on all new development?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
c. Have non-conforming use and structure standards been revised to encourage safer rebuilding in flood-prone areas?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
d. Has the community adopted the International Building Code or American Society of Civil Engineers (ASCE) standards that promote flood-resistant building?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
e. Does the community plan for costs associated with follow-up inspection and enforcement of land development regulations and building codes?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

FLOOD RESILIENCE CHECKLIST

<p>3. Does the community require developers who are rebuilding in flood-prone locations to add additional flood storage capacity in any new redevelopment projects such as adding new parks and open space and allowing space along the river's edge for the river to move during high-water events?</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>4. Is the community planning for development (e.g., parks, river-based recreation) along the river's edge that will help connect people to the river AND accommodate water during floods?</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>5. Does the comprehensive plan or Hazard Mitigation Plan discuss strategies to determine whether to relocate structures that have been repeatedly flooded, including identifying an equitable approach for community involvement in relocation decisions and potential funding sources (e.g., funds from FEMA, stormwater utility, or special assessment district)?</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>Plan for and Encourage New Development in Safer Areas (Learn more in Section 3.C, pp. 26-27 of <i>Planning for Flood Recovery and Long-Term Resilience in Vermont</i>)</p>		
<p>1. Does the local comprehensive plan or Hazard Mitigation Plan clearly identify safer growth areas in the community?</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>2. Has the community adopted policies to encourage development in these areas?</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>3. Has the community planned for new development in safer areas to ensure that it is compact, walkable, and has a variety of uses?</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>4. Has the community changed their land use codes and regulations to allow for this type of development?</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>5. Have land development regulations been audited to ensure that development in safer areas meets the community's needs for off-street parking requirements, building height and density, front-yard setbacks and that these regulations do not unintentionally inhibit development in these areas?</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>6. Do capital improvement plans and budgets support development in preferred safer growth areas (e.g., through investment in wastewater treatment facilities and roads)?</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>7. Have building codes been upgraded to promote more flood-resistant building in safer locations?</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No

FLOOD RESILIENCE CHECKLIST

Implement Stormwater Management Techniques throughout the Whole Watershed

(Learn more in Section 3.D, pp. 27-31 of

[Planning for Flood Recovery and Long-Term Resilience in Vermont](#))

1. Has the community coordinated with neighboring jurisdictions to explore a watershed-wide approach to stormwater management?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
2. Has the community developed a stormwater utility to serve as a funding source for stormwater management activities?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
3. Has the community implemented strategies to reduce stormwater runoff from roads, driveways, and parking lots?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
4. Do stormwater management regulations apply to areas beyond those that are regulated by federal or state stormwater regulations?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
5. Do stormwater management regulations encourage the use of green infrastructure techniques?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
6. Has the community adopted tree protection measures?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
7. Has the community adopted steep slope development regulations?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
8. Has the community adopted riparian and wetland buffer requirements?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

Appendix G:
**Table of Municipal Policy and Program
Recommendations**

Brattleboro

Town-wide Policy and Program Options

Vermont Economic Resiliency Initiative

(VERI)

Legend					
	Effective		Limited		Ineffective

* Priority rating based on degree of community benefit

Recommendation	Priority*	OBJECTIVES			FEASIBILITY		Potential Partners	Potential Grants	Explanation	Next Steps
		Reduces Flood Risk	Reduces Erosion Risk	Protects Businesses, Infrastructure, and Property	Ease of Implementation	Cost Range				
Land Use Regulations										
Consider prohibiting new development in mapped flood hazard area.	High				Medium	< \$10K	WRC, ANR	MPG	New development in the floodplain puts owners at risk, and reduces available floodplain - this raises the flood heights and puts emergency responders, residents and downstream property owners at risk. While the flood hazard portion of the zoning bylaw already requires elevation to one foot above BFE and prohibits development, fill and construction, or net increase of impervious surface in the floodway, it should be considered to prohibit all new development from the mapped flood areas.	Contact Town Planner and Planning Commission
Consider regulating development in fluvial erosion hazard areas.	High				Medium	< \$10K	WRC, ANR	MPG	Much of the flood damage in Vermont is caused by bank erosion from swollen rivers within river corridors. Stream banks can fail causing structures to be undermined or fall into the river. Changes that steer development away from fluvial erosion hazard (FEH) areas help communities qualify for a higher state disaster recovery (ERAF) assistance rate. Consider adding FEH regulations for development in the mapped river corridor into the flood overlay section of the zoning bylaw.	Contact Town Planner and Planning Commission
Limit improvements after the flood.	Medium				Medium	< \$10K	ANR, DEMHS	MPG	When rebuilding after a flood, property owners should limit their improvements to their flood prone properties so any expansions do not create additional hazards to the community. These limits can be added to the development standards portion of the flood hazard section of the zoning bylaw.	Contact Town Planner and Planning Commission
Monitor rebuilding after a disaster.	High				Medium	< \$10K	WRC, FEMA	MPG	People want to return to normal as quickly as possible after a disaster and neighbors and the community can help them do just that but local officials, such as the zoning/floodplain administrator and code enforcement officer, need to monitor their work to ensure that it is not in violation of town and federal regulations. Without close monitoring, improper rebuilding may result in future federal disaster funding being unavailable for the town and its residences and businesses.	Contact Town Planner and Planning Commission
Ensure secondary access for large developments.	High				Medium	Paid for by businesses	Local businesses	MPG	Consider regulations requiring two access roads for any new large development will help ensure access during hazard events. Some developments have become inaccessible during emergency events when a lone access was damaged, destroyed or blocked.	Contact Town Planner and Planning Commission
Provide incentives to regenerate.	Medium				Medium	Depends on scale of incentives	Local businesses, ANR, County Forester	MPG	Consider adopting incentives for restoring vegetation in areas susceptible to flooding. Vegetation is an important part of the floodplain, helping to stabilize it and prevent erosion. Encouraging restoration through providing incentives, financial or otherwise, will increase the amount of vegetation in areas that particularly need it. Additionally, established vegetation will discourage landowners from putting structures in areas that are most susceptible to flooding.	Contact Town Planner and Planning Commission
Consider regulating areas of earth disturbance by means such as grading and vegetation clearing on slopes greater than 15%.	High				Easy	< \$10K	WRC, Consultants, ANR	MPG	These areas are particularly susceptible areas that should be kept out of development to prevent erosion and lessen vulnerability.	Contact Town Planner and Planning Commission

¹Reduces Flood Risk - The proposed project/ strategy lowers the flood level. ²Reduces Erosion Risk - The proposed project/ strategy lessens the vulnerability of a location to erosion.

Brattleboro

Town-wide Policy and Program Options

Vermont Economic Resiliency Initiative

(VERI)

Legend		
	Effective	
	Limited	
	Ineffective	

* Priority rating based on degree of community benefit

Recommendation	Priority*	OBJECTIVES			FEASIBILITY		Potential Partners	Potential Grants	Explanation	Next Steps
		Reduces Flood Risk	Reduces Erosion Risk	Protects Businesses, Infrastructure, and Property	Ease of Implementation	Cost Range				
Town Plan										
The next update to the Town Plan should include a cross reference and discussion of the hazard mitigation plan.	Medium				Easy	< \$10K	WRC, Consultants	HMGF grants	The hazard mitigation plan is currently in draft form, but will be approved and should be considered when doing the next town plan update.	Contact Town Planner and Planning Commission
The next update to the Town Plan should include a more comprehensive flood resiliency/planning section that identifies flood- and erosion-prone areas, including river corridor and fluvial erosion hazard areas.	Medium				Easy	< \$10K	WRC, Consultants	HMGF grants	The current plan does a good job of discussing flood hazards and reducing the impact of flooding and erosion. The state now recommends that a new flood resiliency chapter or element be added to all town plans.	Contact Town Planner and Planning Commission
Hazard Mitigation Plan goals should consider development of green infrastructure.	Medium				Easy	< \$10K	DEMHS, FEMA	HMGF grants	Green infrastructure provides a natural and low-tech way to control and lessen stormwater and floodwater.	Contact Town EMD
Document damages from flood events.	High				Easy	< \$10K	Vtrans, WRC	MPG	Disasters are easily forgotten over time and damages from the 2011 floods as well as other smaller recent rain and flood events should be documented. This will help the community consider the implications of new investments in areas damaged by floods. The state now recommends that a new flood resiliency chapter or element be added to all town plans.	Contact Town EMD
Document road, sewer, and water infrastructure vulnerabilities in municipal and capital plans.	High				Medium	< \$10K	Vtrans, WRC	MPG	Specific areas that were damaged or have known vulnerabilities should be documented so the community can plan for their replacement in their long-term budgets, easing the impact on taxpayers. Capital programs and budgets are not common in smaller towns but the local Selectboard may start this process with a list and a capital reserve fund. More detailed budgets and plans can be developed with the help of your RPC and financial advisors.	Contact Conservation Commission
Identify areas for conservation.	Medium				Easy	< \$10K	Corridor Plans identify these areas, Land Trusts, ANR	MPG	The Whetstone Brook Corridor Plan and the Crosby Brook both identify potential riparian easement sites. The Conservation Commission can identify and work with willing landowners to establish those riparian easements to prevent future development in flood-prone locations.	Contact Conservation Commission

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Brattleboro

Town-wide Policy and Program Options

Vermont Economic Resiliency Initiative (VERI)



* Priority rating based on degree of community benefit

Recommendation	Priority*	OBJECTIVES			FEASIBILITY		Potential Partners	Potential Grants	Explanation	Next Steps
		Reduces Flood Risk	Reduces Erosion Risk	Protects Businesses, Infrastructure, and Property	Ease of Implementation	Cost Range				
Emergency Planning										
Ensure that town staff is kept up to date on all training requirements.	High	◐	◐	●	Easy	< \$10K	DEMHS, LEPC 6	MPG	NIMS/ICS training for senior staff and continuing training for emergency responders; training will facilitate coordination of town and multi-agency response to local or regional hazards. Town is coordinating training with other local agencies, including Brattleboro and regional schools.	Work with local committee
Maintain the energy around school crisis planning.	High	◐	◐	●	Easy	< \$10K	Police Department, Fire Department, School Administration, etc.	MPG	Brattleboro has been a key partner in facilitating a multi-agency planning effort to update the School Crisis Plan with table top exercises, staff training, and planned drills. The training effort includes identifying, purchasing and staging materials needed for an emergency response. The plan has become a model in the state. Continue to work collaboratively with the school district to maintain the plan.	Contact Town Emergency Management Director and Principal
Set up appropriate list serves for use during emergencies.	Medium	◐	◐	●	Easy	< \$10K	None needed	HMGP grants	The ability to reach a number of people at once is the primary benefit of VT Alert. Examples of who could be included are town staff, school personnel, business owners, regional commission staff, public infrastructure staff, and residents. Various lists can be set up for specific purposes or types of emergencies.	Work with town Emergency Management Director.
Identify structures in the dam inundation area for emergency alerts.	Medium	●	◐	●	Easy	< \$10K	WRC	HMGP grants	There is a mapped dam inundation area for dam breaks on the West River. The map also captures inundation risks for most areas of Brattleboro for a dam break on the Connecticut River. An inundation wave will take an hour or more to propagate downstream to Brattleboro. The use of the Code Red public mass notification system to alert residents of structures at risk will reduce loss of life.	Work with town Emergency Management Director.
Create a Drought Response Plan.	Low	◐	◐	●	Medium	< \$10K	WRC	HMGP grants	In the past, drought response has been ad hoc. Creating a policy will help identify appropriate conservation actions for given drought conditions. The policy can outline public outreach actions. Adequacy of backup water supplies will be examined.	Work with town Emergency Management Director.
Develop protocol for collecting and maintaining records of damage information.	High	●	◐	●	Easy	< \$10K	WRC, DEMHS	EMPG	Information about past damage, including repair costs, is pivotal in doing Benefit Cost Analysis (BCA) for grant funded projects down the road. Having the data available at hand will make life easier and will put Brattleboro in a better position to receive funding for hazard mitigation projects.	Work with town Emergency Management Director.

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Brattleboro

Town-wide Policy and Program Options

Vermont Economic Resiliency Initiative

(VERI)

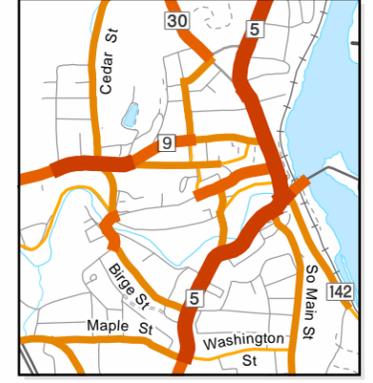
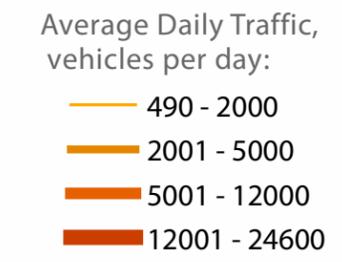
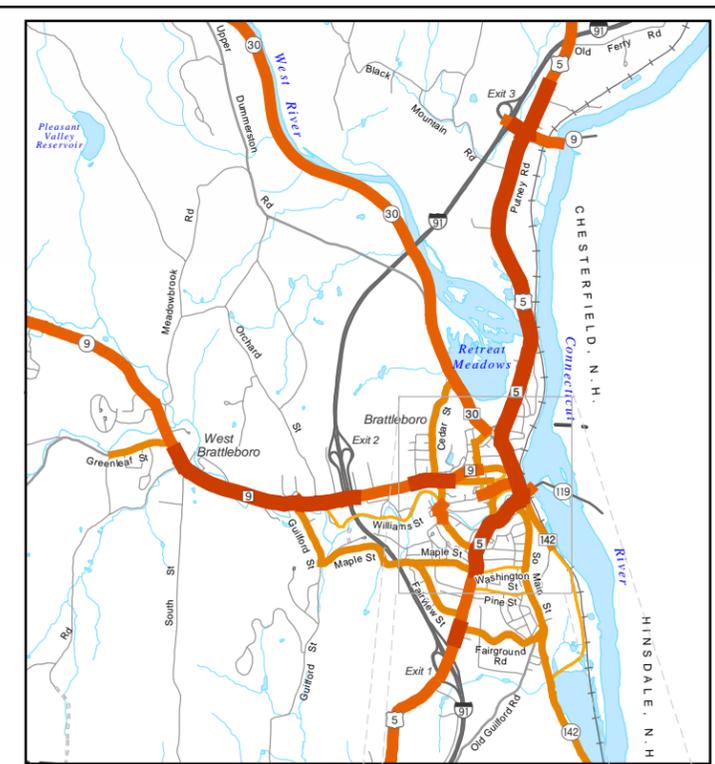
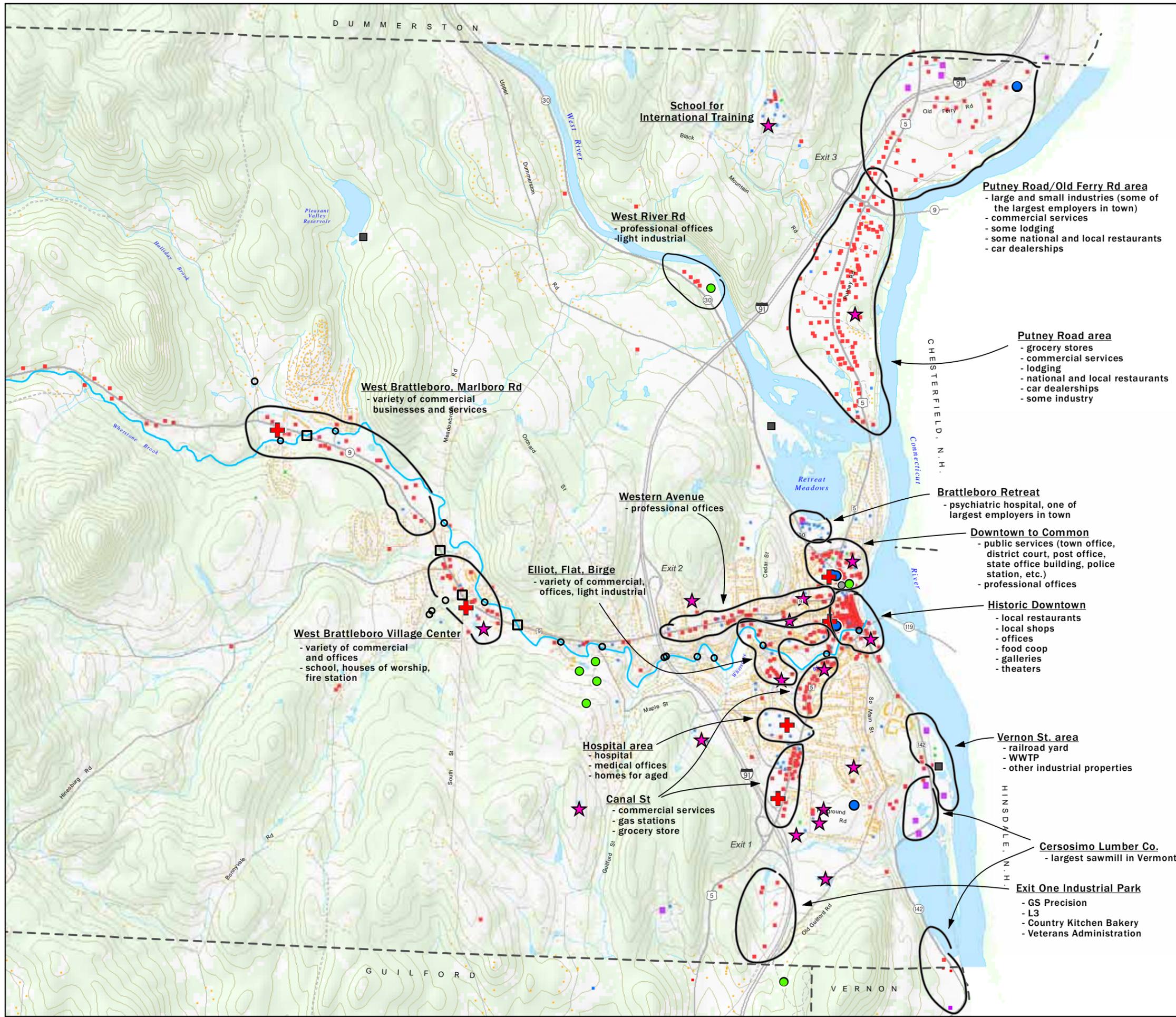
Legend					
	Effective		Limited		Ineffective

* Priority rating based on degree of community benefit

Recommendation	Priority*	OBJECTIVES			FEASIBILITY		Potential Partners	Potential Grants	Explanation	Next Steps
		Reduces Flood Risk	Reduces Erosion Risk	Protects Businesses, Infrastructure, and Property	Ease of Implementation	Cost Range				
Emergency Planning										
Keep Local Emergency Operation Plan (LEOP) updated each year.	High				Easy	< \$10K	WRC, DEMHS	EMPG	During a disaster, having quick access to the local public and private contacts in town for all of the critical systems and vulnerable populations is indispensable. The LEOP should include the local private water utility and municipal sewer superintendents in the contacts section.	Work with town Emergency Management Director.
Develop a local recovery plan and fund.	High				Easy	< \$10K	None needed	VT Community Foundation	Towns will recover much more quickly after a disaster if they can marshal their own resources. Federal and state money will come, but these funds are slow to arrive. A local household and business small grant and loan fund is proven to speed recovery efforts.	Work with town Emergency Management Director.
Develop a local retrofit fund.	Low				Easy	< \$10K	None needed	VT Community Foundation	Again state and federal grants take time and may not be available for small projects. As part of the recovery or pre-disaster mitigation plan and fund, towns could offer mini grants for retrofits such as backflow preventers (that keep stormwater and sewage from flooding buildings via the draining system), elevation of exterior utilities, and flood barriers for doors.	Reach out to schools and community groups.
Continue to participate in the Community Rating System and work to achieve a higher rating.	High				Easy	< \$10K	WRC, DEMHS, FEMA	HMGP grants	Brattleboro should apply for a higher rating within CRS based on land preservation efforts, outreach efforts, elevation certificates, higher standards in the floodplain ordinance, and stormwater regulations. A higher rating will mean better flood insurance rates for residents and businesses.	Contact Town Planner and /or Zoning Administrator
Education and Outreach										
Help businesses plan for disasters.	High				Easy	< \$10K	WRC, DEMHS	HMGP grants	If a home is damaged or washed away, occupants can go stay in a hotel, with friend or family, or find a rental. When a business is flooded, it is much harder or impossible to relocate. Continuity of operations plans outlines the steps business can take during and after a disaster to reduce disruption and losses.	Offer continuity of operations planning training for businesses.
Educate landlords and contractors about flood resilience.	Medium				Easy	< \$10K	WRC, DEMHS	HMGP grants	Many landlords and contractors may not understand the requirements for rebuilding after a flood. Specific standards must be met to maintain eligibility for flood insurance and other federal grants. Education programs are critical component to raising awareness.	Reach out to landlords and contractors.
Promote and educate property owners on the value of flood insurance.	Medium				Easy	< \$10K	WRC, DEMHS	HMGP grants	Homeowners insurance does not pay for any flood related damage. Only flood insurance does. In Brattleboro, only 44% of buildings in the flood hazard area have flood insurance.	Gather NFIP materials and set up training for realtors and other groups

¹Reduces Flood Risk - The proposed project/ strategy lowers the flood level. ²Reduces Erosion Risk - The proposed project/ strategy lessens the vulnerability of a location to erosion.

Appendix H:
Economic Zones Map



Downtown inset

- Government/municipal services
- Cultural, educational, health
- Commercial
- Industrial
- Residential
- Unknown/other

Municipal Facility:

- municipal services
- + public safety/health services
- ★ education
- parks/recreation
- utility
- other

Bridges in Whetstone Corridor:

- Route 9
- other roads

Appendix I:
Bridge Summary Table

Reach	Bridge #	Road Name	Span	Channel Width	Bankful Width	Post Irene Note	VTRANS Inspection
M07	60	Westgate Drive	26'	36'	52'	minor erosion; armored corners of bridge	9/6/2012 'structure is in good condition. Channel repairs should be made up and downstream.'
M07	51	Route 9	76.3'	36'	52'	minor erosion; state armored bridge'	6/6/2013 Both skeleton abutments filled in with concrete between the legs to help stop the undermining. Pavement should be removed and deck repaved in the near future. More riprap should be install on the banks up and downstream.
M06C		Detman Drive	52'	47'	38.5'	None	None
M06B	11	Meadow Brook	47'	47'	50.6'	minor erosion at bridge'	9/6/2012 'structure is in good condition'
M05A	58	George F. Miller Drive	57'	54'	60'	'minor erosion; added stone'	9/6/2012 'structure is in good condition sidewalks should be clean of all loose material and patched'
M05A	54	Route 9	55'	54'	60'	'minor erosion; added stone'	6/17/2013 'structure is in fair to good condition. Stone should be added to the south end of the arch to help stop the scour.'
M04	51	Brookside Drive	42'	55'	52'	None	9/6/2012 'structure is in good condition'
M04	30	Guilford Road	90'	55'	61'/52'	None	6/19/2014 'structure is in good condition'; 6/28/2012 ;structure is in good condition. New in 2010'; 11/2/2011 'minor washout on abutment2 upstream bank and abutment 1 downstream bank from hurricane Irene.'
M02		I91		56'	67'		New in 2013

Reach	Bridge #	Road Name	Span	Channel Width	Bankful Width	Post Irene Note	VTRANS Inspection
M02	34	Williams Street (west)	96'	56'	67'	SW abutment washed out, did some stone armoring	6/19/2014 'structure is in good condition. Beams should be spot cleaned and repainted.
M02	35	Williams Street (east)	103' (functionally 52' due to sediment in right opening)	56'	67'	washout behind E abutment, hole in bridge, bridge closed for several weeks	6/19/2014 'gravel bar should be removed from the upstream channel. Beams could be spot cleaned and painted. Should consider repaving soon. Curbs should be cleaned and patched. 6/28/2012 Abutments should be monitored after high water.
M01D	31	Elliot	87'	56'	60'	None	6/19/2014 Deck will need rehab in the near future. Both laidup stone abutments could use some mortar work. Beams should be cleaned and painted. Tubing rail should be repaired and repainted. 6/28/2012 Structures deck will need to be rehabbed.
M01B	32	Elm	85'	56'	54'	None	6/23/2014 Structure is in good condition. Spindles on the bridge rail should be repaired.
M01A	7	Main Street	61'	65'	n/a	None	5/22/2013 Structure is in good condition. The small delams on the downstream fascia should be cleaned and patched.

Appendix J:

Eastern Williams Street Bridge Conceptual Design

Eastern William Street Bridge (B35, at West Street) sediment management (Site 15)

Overview and Objectives

The total bridge span of 103' is adequate to pass the channel forming flow (bankfull width is 67') however, sediment has built up in the right (facing downstream) opening allowing water to pass only in the 52' wide left side opening.

Removing sediment from upstream of, and in the right (facing downstream) opening of the bridge will decrease the likelihood of this bridge being damaged or washed out during a flood event. Williams Street provides redundancy in the transportation connection to the downtown.

By increasing channel and bridge capacity, the project will reduce the potential impact of debris jams during a flood event and reduce the erosive energy moving through the bridge (Figure 11). This project was identified during the site visit in September of 2014 and also called for in a VTRANS bridge inspection done June, 2014 (VTRANS, 2014) which also suggests monitoring of the abutments following high water. Approximately 450 cubic yards of material would need to be removed at \$10/yard (\$5,000). Permitting and planning would be an additional \$5,000.

Steps for Project Implementation

Landowner outreach would be the first step to move this project forward as permission for site access is needed. (NOTE: There is an old access area upstream of the jam site that could be utilized). The next step would be to identify sources of and apply for funding. There is a need to field measure the volume of material to be removed. All necessary state and federal permits would be required, including additional assessment of disturbance to rare, threatened, or endangered species and an archeological evaluation. An area for, or a use of, removed material would need to be located and the project put out to bid and implementation overseen.



Figure 10: Easterly Williams Street Bridge 2008



Figure 11: Easterly Williams Street Bridge excavation area

Undertaking no action at this site is likely to lead to increased scour and possibly to undermining of the currently sound bridge structure.

Project Benefits

The implementation of this project is anticipated to provide benefits for reducing flood risks in Brattleboro. These benefits include:

- Maintain redundancy in the transportation network to greater than 60 businesses and more than 500 employees downtown;
- It is a relatively easy project that can build on past successes; and
- It will improve channel capacity, reducing the possibility of a debris jam causing water and sediment to back up and flood upstream areas.

Appendix K:
Housing Study

MEMORANDUM

TO: Adam Hubbard, Stevens & Associates

FROM: Roy Schiff and Jessica Louisos, Milone & MacBroom

DATE: June 15, 2012

RE: Whetstone Brook

Introduction

An alternatives analysis has been performed to reduce flood risks along Whetstone Brook in West Brattleboro, Vermont as part of a redevelopment project being undertaken by the Brattleboro Housing Authority. Existing data were reviewed and field reconnaissance was performed to inform the analysis.

The primary project site is approximately 2 miles of Whetstone Brook and its floodplain between the Dettman Drive and Route 9 Bridges in West Brattleboro. The area has mixed land use that includes commercial and residential development, agricultural fields, and woods. Repeated flooding occurs at the project site. Much of the improved public and private infrastructure is located in the river corridor where a FEMA mapped floodway and floodplain exist. (The floodway is the primary flow area during a large flood and the floodplain is the extent of the inundation during the flood.) Alternatives are being explored at two housing complexes – Melrose Terrace and Hayes Court – to reduce flood risks and repeated damages at flood-prone structures. Alternatives are also being considered at Glen Park and Mountain Home Mobile Home Parks, as well as other locations in the river corridor.

Whetstone Brook

Whetstone Brook (watershed area ~ 28 square miles) is a mountain stream that originates in Marlboro and flows east through Brattleboro to the Connecticut River. The channel setting follows a trend that is common in Vermont where a steep channel flows out of the mountains in a narrow valley and then enters a broader valley where the slope of the channel decreases. The slope of Whetstone Brook is around 4% in upstream reaches and then it drops to 2.0% approaching the West Brattleboro project site, and is near 0.5% at the project site (Sheldon, 2008). Full natural valley width is 150 feet in the upper watershed and grows to around 1,000 feet near the project site (Figure 1). As the channel slope declines and the valley broadens, floodplains form and sediment deposition takes place leading to a channel that is likely to move around the landscape during floods. Channel movement is closely linked to sediment bar formation in deposition areas (FHWA, 2001). Many Vermont villages are located in these areas with some of the highest risks of flood and channel erosion hazards due to historic land use patterns.

The flatter locations with wide valleys are often confluence locations where two river channels join. Confluence areas such as where Ames Hill Brook and Halladay Brook join Whetstone Brook are known to be some of the most flood-prone areas on the landscape. Confluence locations are known to be dynamic due to abrupt changes in flow, sediment transport, channel shape, and flood hydraulics that can result in increased erosion and deposition (Benda et al., 2004).

Many Vermont valleys that were formed by river erosion now contain permanent infrastructure leading to a high degree of unnatural valley narrowing (i.e., confinement or floodplain encroachment). Channel confinement in the Whetstone Brook river corridor at the project site is 60% of the full valley width on average, with a local maximum of 80% in several locations. Confinement also exists in the upstream narrow corridor due to the presence of Route 9 (35%) and downstream in Brattleboro (75%). Confined channels tend to be more erosive and unstable than those connected to floodplains. Narrowing of the valley due floodplain development has set the stage for repeat damages during floods on Whetstone Brook.

Efforts to protect Vermont villages and roads have been taking place for centuries that include channel straightening, berming, bank armoring, sediment dredging, and moving out of the floodplain. The limited success of many of the historic active channel approaches that are costly to implement after each flood has led to a recent increase in the consideration and implementation of alternatives to remove flood-prone structures from floodplains and conserve these areas to permanently minimize future risks. In many Vermont villages that have abundant infrastructure exposed to flood and erosion risks, a mix of alternatives is needed to reconnect available floodplains while safeguarding improved property that will remain in the river corridor.

History shows that on average damaging floods tend to occur on Whetstone Brook every 30 years (Sheldon, 2008). The response to these events has left many reaches straightened and isolated from natural floodplain areas due to berming to protect improved property. For example, 5 miles of the 13-mile long channel (40%) has been straightened in the past. Much of the existing floodplain along Whetstone Brook contains roadways and buildings, and thus there is no safe place for the channel to drop sediment, store flood waters, and dissipate energy during flooding. On average, 20% of the floodplain cross sectional area is filled with infrastructure at the project site (Figure 2). The current project provides an opportunity to consolidate housing and re-connect historic floodplain to reduce future flood risks. The more floodplain available for flood water and sediment storage, the less flood damages will take place.

Tropical Storm Irene

A large flood took place on Whetstone Brook on August 28, 2011 during Tropical Storm Irene. Stream gauges do not exist on the brook, so flood estimations and regional flood data were reviewed to estimate the size of the flood. The predicted 100-year flood (i.e., the flood that has a 1% chance of occurring in each year) is 7,400 cubic feet per second (cfs) based on the effective FEMA flood insurance study (FEMA, 2007). Another estimate using the USGS StreamStats equations (Olson, 2002) indicates the 100-year peak flood on Whetstone Brook is 3,000 cfs (prediction range of 1,500 to 6,000 cfs).

Some of the highest rainfall amounts in Vermont during Tropical Storm Irene took place in the headwaters of the Whetstone Brook watershed. National Weather Service data indicate that more than 8 inches of rain fell in some mountain areas of Windham and Bennington Counties. The nearest USGS gauges on the Walloomsac River and Saxtons River both recorded floods of record since data collection began. The flow on the Saxtons River was 14,700 cfs (larger than the 100-year flood) and the peak flow on the Walloomsac River was 9,420 (estimated to be an 85-year flood). These data indicate that the 2011 flow on Whetstone Brook was possibly 5,000 cfs and likely between a 50- and 100-year flood.

Several previous flood studies have been performed along Whetstone Brook (See Sheldon, 2008). One study (USACE, 1972) illustrates the level of the 100-year (i.e., intermediate regional) flood. Flood waters are predicted to rise to nearly 3.5 feet above the ground surface at the upstream end of Melrose Terrace and Glen Trailer Park during the 100-year flood (Figure 3). The water marks on buildings after Irene observed in May were 1 to 2 feet from the ground providing verification that the flood was likely between a 50- and 100-year event.

Some of the observed flood water surface elevations around Vermont during Irene were higher than flow data would suggest due to many channels being filled with sediment from erosion in the mountains. As sediment reached flatter areas in Village centers deposition took place reducing flood conveyance and flood waters spilled out of the banks often cutting a new channel path (i.e., channel avulsion took place). A channel avulsion occurred at the upstream limit of the Melrose Terrace property where deposited sediment redirected the channel to flow over the flood wall and down the non-river side of Melrose Street. Avulsions due to sediment erosion and deposition do not follow normal inundation-based flood mapping and create unique flood patterns. For example, several properties in the 500-year floodplain at Melrose Terrace were damaged as water flowed along their foundation to find a path back to the main channel while some properties in the floodway had less damage.

A map showing the extent of flooding along Whetstone Brook during Tropical Storm Irene does not exist. Flooding, avulsion, and erosion led to river corridor damages. Portions of Route 9 were washed out in the confined valley upstream of West Brattleboro. Sediment deposition caused channel avulsion and flooding in the wider floodplain areas in the vicinity of the West Brattleboro project leading to damage of many structures. Downtown Brattleboro was flooded approaching the Connecticut River, severely impacting the downtown area. Many mobile homes, residential buildings, and commercial structures were damaged.

Alternatives Analysis

As the Brattleboro Housing Authority considers plans for updating and expanding units at Melrose Terrace and Hayes Court, and possibly in conjunctions with changes at Glen Park and Mountain Home, the recent flood has illustrated the need to carefully consider residential development alternatives in the context of Whetstone Brook and its floodplain. The current project provides an opportunity to reduce flood and erosion risks to provide safer housing in the area. Several flood protection and flood avoidance alternatives have been explored to see how each achieves the following project objectives:

- Reduce flood risks;

- Reduce erosion risks;
- Eliminate flood-prone structures that are repeatedly damaged;
- Maximize the number of housing units;
- Protect existing structures from flooding;
- Re-connect historic floodplain where possible;
- Maximize the ease of construction;
- Develop a project with straight forward permitting needs; and
- Control project costs.

A mix of floodplain re-connection and structural flood protection are being explored and it is likely that a combination of approaches will be needed to address the abundance of improved infrastructure that is prone to flooding at the project site as well as the limited available space for the housing stock that the Housing Authority is seeking to improve. Although not directly addressed in this analysis, new structures should contain the most aggressive flood-proofing methods possible to limit future damages in the flood-prone Whetstone Brook corridor. For example, utilities should be raised above design flood level. Parking lots could be located on the first floor of larger buildings to limit damages when flooding and sediment deposition do take place.

The actions taken in West Brattleboro are important to break the cycle of channel confinement, flood damage and costly channel management that have dominated this area and many other locations across Vermont. The preferred alternative must reduce channel confinement and must not lead to increased flooding and erosion downstream in the developed river corridor that includes downtown Brattleboro.

Melrose Terrace (See Figure 4 and Table 1)

Alternative 1: No Action

The no action alternative maintains the current housing stock of eighty residential units, yet is not recommended due to the persistence of flood-prone conditions along Whetstone Brook described above.

Alternative 2: Improve Flood Wall

Improving the existing flood wall along Whetstone Brook would provide structural flood protection to the complex. The wall would need to be tied into the higher ground at the valley wall location on the abutting property upstream of the property. The flood wall at the upstream end of the property would need to be taller to prevent a channel avulsion at Melrose Street. The gaps in the existing wall would need to be connected.

A taller and more complete wall would reduce aesthetics at the site making a more formidable barrier between the channel and homes. Flood risks would remain at the local project site due to the persistence of 80% narrowing of the valley and structures being located in the floodway and floodplain. The wall would be under threat of frequent erosion and thus would need to have a robust design. Downstream flood risks would increase if a larger flood wall was built at the

project site as the flood waters, sediment, and erosive power released during avulsion would be transferred downstream. Flood risks would increase at George F. Miller Bridge.

The alternative of solely building an improved flood wall between Melrose Terrace and Whetstone Brook is not recommended as the negatives outweigh the positives.

Alternative 3: Remove Buildings in Floodway and Construct New Flood Wall at Upstream End of the Property

This alternative attempts to balance flood risk reduction and maintaining housing units by removing the structures that are likely most vulnerable during floods and installing a new flood wall to limit the chances of channel avulsion through the project site. Seven buildings and the existing flood wall would be removed from the floodway. A new flood wall would be constructed approximately 100 feet back from the river channel along the edge of the floodway from the upstream valley wall to the George F. Miller Bridge. The adjacent upstream landowner would have to partner on this alternative as the flood wall would cross that property.

Removal of the buildings would eliminate the flood-prone structures, open up 1.9 acres of floodway and low floodplain for the brook, and increase the width of the valley that can be occupied by the brook without property damage by 95 feet. Downstream flood risks would be reduced due to the re-connection of new floodplain.

The down side of this alternative is that seven existing residential buildings would be removed from the local housing stock and would need replacement. Remaining buildings at Melrose Terrace would still be exposed to some flood risk given their location in the fluvial erosion hazard zone and floodplain. The taller flood wall on the upstream end of the property would reduce aesthetics. Permitting the construction of new residential buildings in the flood-protected area would be complicated due to the history of flooding in the area and the fact that many of the new buildings would remain in the fluvial erosion hazard zone and regulated floodplain.

The alternative to remove structures from the floodway and construct a new flood wall is not recommended. Although this approach would result in both re-connected floodplain and a location to build safer housing, the extreme level of confinement that exists in this area suggests that pulling farther away from the river is desired to allow for a safer and more beneficial redevelopment project.

Alternative 4: Remove Buildings in the Fluvial Erosion Hazard Zone and Construct New Flood Wall at Upstream End of the Property (Preferred)

This alternative attempts to reduce flood and erosion risks while maintaining existing housing units that could be improved in the future. Buildings in the floodway and the Vermont fluvial erosion hazard zone that are most vulnerable to damage would be removed. A flood wall would be constructed along the upstream portion of the fluvial erosion hazard zone boundary to limit the chances of channel avulsion. Eleven Melrose Terrace residential buildings would be removed from the floodway and fluvial erosion hazard zone. The flood wall would pass near the

house on the upstream adjacent property so this property would likely need to be purchased and the building removed as part of this alternative.

The building removals would eliminate flood-prone structures from the location where the river is expected to be the most dynamic. Floodplain would be re-connected over 4.4 acres, and 140 feet of valley width would be re-connected to the channel.

This alternative further cuts into the available housing above previous alternatives and thus replacement of the existing units would be essential. This alternative would be a good path forward for a site-level redevelopment project where the combination of floodplain re-connection and new flood wall would create a safer housing setting to locate several structures.

The compromise between housing and reduced flood risks associated with this alternative is appealing. Although floodplain fill would likely take place and some flood hazards would remain, this alternative would be an important step in a positive direction to reduce local and downstream flood risks. Maintaining an open fluvial erosion hazard zone would likely lead to simplified permitting and gather support for the project at the local, state, and federal level. Removing buildings in the fluvial erosion hazard zone and constructing a new flood wall is the preferred alternative.

Alternative 5: Remove All Existing Buildings and Construct Large Residential Building Outside of the Floodplain

Removing all buildings in the floodway, fluvial erosion hazard zone, and 100-year floodplain and building a large residential building near the slope at the back of the project area would provide great benefits to flood and erosion risk reduction. Over 5.9 acres of floodplain would be reconnected and the channel would be able to safely occupy 315 feet of its valley, or nearly half of the natural valley width. Flood walls would not be needed since all flood-prone buildings would be removed and thus a large area for flood water and sediment storage would be established. This alternative would reduce downstream flooding.

Eliminating all existing housing units at Melrose Terrace is a negative aspect of this alternative. Beyond the proposed large building at the back of the property more units would need to be re-located to cover the housing need. An adjacent property along the slope may need to be purchased to provide adequate space for a building that is large enough to justify the development.

Although this alternative is excellent in terms of flood risk reduction, it is not preferred given the large loss of housing.

Alternative 6: Remove All Existing Buildings and Abandon Site

The alternative of abandoning the Melrose Terrace site is not recommended as there appears to be an area where a sound compromise of flood risk reduction and providing safe housing exists. Limited locations to provide housing in West Brattleboro illustrate the need to maximize use of

available space – as long as the space is expected to be acceptably safe from future flood damage.

Alternative 7: Enlarge George F. Miller Drive Bridge

The FEMA flood profile illustrates that the George F. Miller Bridge backs up water and elevates flood levels during the 50-, 100-, and 500-year floods. The bridge is located near several buildings in the floodway and floodplain that also constrict flow during flooding. The combination of the bridge and the floodplain development make this location especially prone to flood damage. No safe flood path exists once the bridge opening is filled with water, sediment, and debris during a flood.

Flood waters are elevated from the bridge to the upstream extent of the Melrose Terrace property. Widening the structure would reduce local flood levels and improve sediment transport. Bedrock exists around the bridge and the rock controls the channel bottom elevation so it cannot cut down even in its confined and undersized condition. Without the rock the bridge would be prone to scour.

It is not known if the expansion of George F. Miller Drive Bridge is a preferred alternative at this time given that it needs to be considered in the context of the primary preferred alternative at Melrose Terrace. What is clear is that the bridge should be enlarged in the future when it is replaced due to reaching the end of its engineering life or after failure.

Alternative 8: Enlarge Route 9 Bridge

The FEMA flood profile illustrates that the Route 9 Bridge near Melrose Street backs up water and elevates flood levels during the 50-, 100-, and 500-year floods. Flood waters are elevated from the bridge upstream to near the most downstream residential building in Melrose Terrace. Widening the structure would reduce local flood levels and improve sediment transport.

It is not likely that the expansion of the Route 9 Bridge near Melrose Street is a preferred alternative given that it appears to influence mostly downstream of the project site. Actions at that bridge need to be considered in the context of the primary preferred alternative at Melrose Terrace and with an understanding of possible downstream changes. Like George F. Miller Drive Bridge, the Route 9 Bridge should be enlarged in the future when it is replaced due to reaching the end of its engineering life or after failure.

Hayes Court (See Figure 5 and Table 1)

Alternative 9: No Action

The no action alternative maintains the current housing stock of seventy-two residential units, yet is not recommended due to the persistence of flood-prone conditions along Whetstone Brook described above. Hayes Court residential buildings are in need of renovation and the opportunity exists to move housing back from Whetstone Brook to reduce flood risks.

Alternative 10: Remove Two Buildings and Cul-de-Sac, and Re-Connect Low Floodplain (Preferred)

Removing the two lowest buildings that had flood waters adjacent to them during Tropical Storm Irene due to combined flow from Ames Hill Brook and Whetstone Brook would remove two flood-prone structures and allow for re-connection of 1.9 acres of floodplain. The valley width that the channel could safely occupy would be expanded by 108 feet. The two remaining residential buildings could remain, or site redevelopment could take place in areas located on existing fill. Ample space exists to site three to four large additional residential buildings. This alternative would move all development out of the fluvial erosion hazard zone. The proposed limit between re-connected floodplain and site redevelopment has been moved up-gradient to reduce risks based on site conditions at the confluence and patterns of flooding observed during Irene.

A portion of the remaining road and the buildings may be vulnerable to flood risks under this alternative due to the dynamic confluence area so it is likely that roadway reconfiguration would take place to move back from Ames Hill Brook as much as possible. Garfield Drive may need to be relocated away from Ames Hill Brook to limit future damage. Some filling may be necessary to elevate the portion of the site to be redeveloped outside of the floodplain where some fill already exists.

Weighing the positives and negatives at Hayes Court, including the likely need to create housing units in this location to replace more flood-prone units in Melrose Terrace, this alternative is preferred. From strictly a flood risk reduction point of view, more floodplain would be desired at this site to create safer and more natural conditions in this wide valley, deposition-prone area. However, the ability to provide housing opportunity in conjunction with floodplain re-connection outside of the currently mapped 100-year floodplain and fluvial erosion hazard zone is desired.

This alternative should be performed in conjunction with floodplain re-connection at the nearby farm fields off of Meadow Brook Drive that are conserved with the Vermont Land Trust. This large field has the potential to provide a large amount of storage during extreme flood events if at the appropriate elevation compared to the channel.

Alternative 11: Remove Two Buildings in Low Floodplain, Remove South Building Located in the Filled Area, and Re-Connect Portion of Historic Floodplain

Removing the three lowest buildings at Hayes Court would allow for re-connection of 3.3 acres of floodplain. The valley width that the channel could safely occupy would be expanded by 290 feet. The one remaining residential buildings could remain, or site redevelopment could take place in upland areas on the existing fill. Ample space exists to site three large residential buildings.

The flood risk reduction benefits are substantial for this alternative. The amount of the 1,080-foot wide natural valley that is occupied by improved property would drop from 39% to 13% providing a large space for flood water and sediment storage. Historic fill could be removed to re-connect substantial floodplain area in this flat sediment deposition-prone area.

The primary negative aspect of this alternative is the loss of existing developable lands that would likely only be flooded or eroded during very rare events such as those larger than Tropical Storm Irene.

This alternative is only recommended if other suitable locations are available to replace housing units from the project area to allow for a further increase in flood risk reduction.

Alternative 12: Remove All Buildings in Low Floodplain and Filled Area, and Re-Connect Majority of Historic Floodplain

Removing all existing buildings at Hayes Court would allow for re-connection of 3.9 acres of floodplain. The valley width that the channel could safely occupy would be expanded by 335 feet. Mapping and site observations indicate that this may be the historic floodplain extent prior to filling in the past for the existing development. Site redevelopment would take place in upland areas on the back edge of the existing terrace where some filling has taken place. Space would remain to site two large residential buildings.

Re-connecting the maximum floodplain area at Hayes Court would reduce flood and erosion risks the most in this area. The full valley width would nearly be opened back up for the river to flood and deposit sediment without damaging infrastructure. This alternative would reduce downstream flooding as long as the design considered the approach and possible flow paths at Glen Park.

This alternative limits the development potential at Hayes Court. Residential units would need to be replaced at other locations away from Whetstone Brook.

This alternative is only recommended if other suitable locations are available to replace housing units from the project area to allow for the maximal increase in flood risk reduction.

Glen Park (See Figure 6 and Table 1) and Mountain Home (See Figure 7 and Table 1)

Alternatives were also explored at Glen Park and Mountain Home given their flood-prone condition and proximity to Hayes Court and Melrose Terrace. Activities in these two locations should be coordinated with the alternatives discussed above, because both depend upon and influence actions taken at Hayes Court and Melrose Terrace. Alternatives may be viewed on maps and the matrix, and more details will be provided as necessary.

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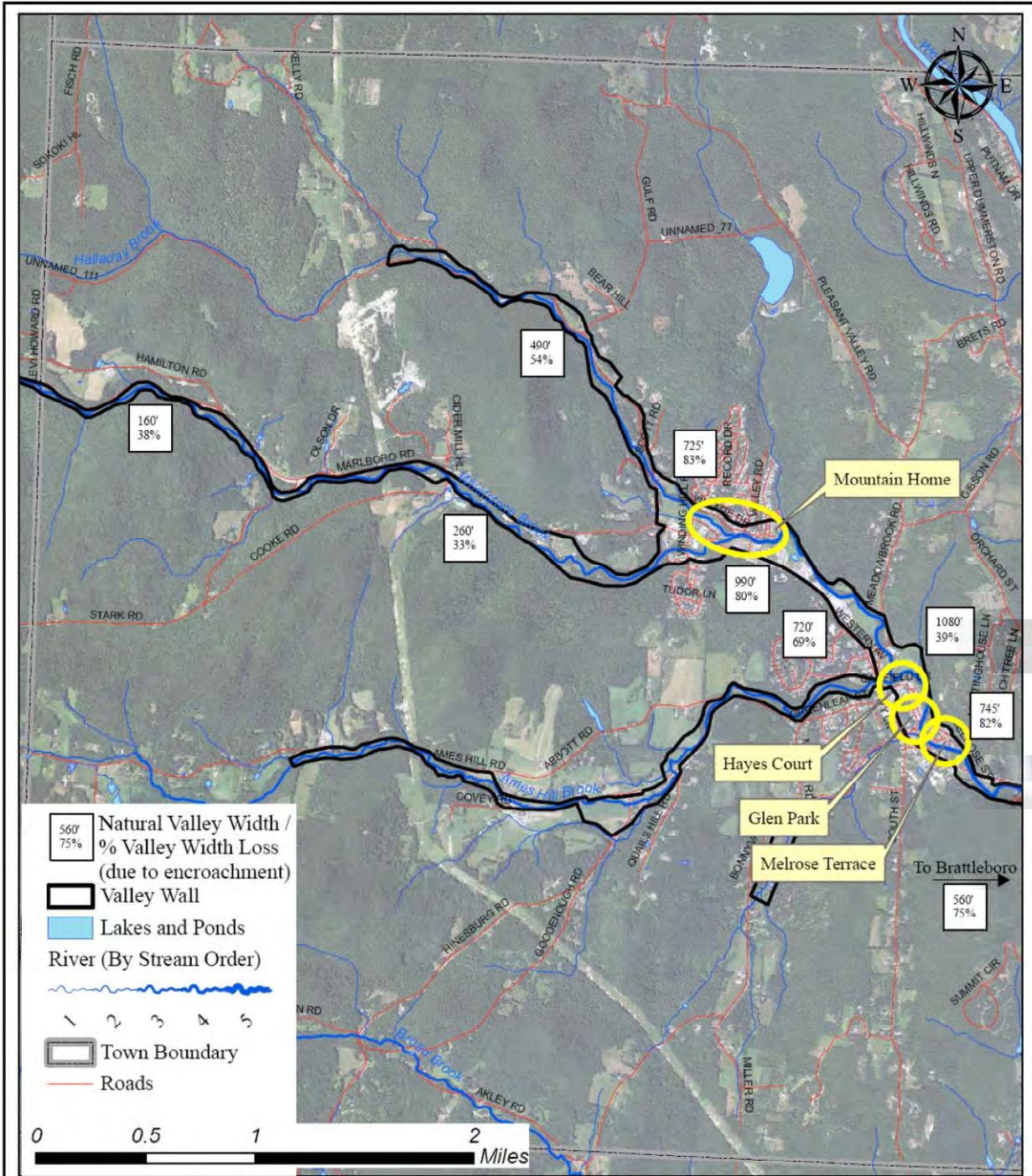
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OBJECTIVES

Location	ID	Alternative	Reduce Flood Risks	Reduce Erosion Risks	Eliminate Flood-Prone Structures	Maximize Housing Units	Flood Protect Structures	Re-Connect Floodplain	Constructability	Permitting	Cost	Notes
Melrose Terrace	1	No Action	-	-	-	+	-	-	+	+	+	80 existing residential units.
Melrose Terrace	2	Improve wall around perimeter of complex to make higher and complete. Tie to higher ground at upstream end of property.	-	-	0	+	0	-	-	-	0	Requires cooperation of abutting landowner.
Melrose Terrace	3	Remove seven (7) buildings in floodway, re-create floodplain in area near river, improve existing wall to tie to high ground to prevent avulsion at upstream end of property.	0	0	0	0	-	0	+	0	0	Requires cooperation of abutting landowner.
Melrose Terrace	4	Remove eleven (11) buildings in fluvial erosion hazard zone and re-create floodplain in area near river, improve existing wall to tie to high ground to prevent avulsion at upstream end of property.	0	0	0	0	-	+	+	+	0	Requires purchase of adjacent lot and removal of existing house.
Melrose Terrace	5	Remove all buildings, create new floodplain, and construct large residential building on back edge of floodplain at slope.	+	+	+	-	0	+	0	-	-	May require purchase of adjacent lot.
Melrose Terrace	6	Remove all buildings and abandon site for floodplain creation. All residential units to move to buildings at Hayes Court or other location.	+	+	+	-	+	+	+	+	0	
Melrose Terrace	7	Enlarge bridge on George F. Miller Drive.	+	0	-	-	-	-	0	0	-	
Melrose Terrace	8	Enlarge bridge at Route 9.	0	0	-	-	-	-	0	0	-	

Hayes Court	9	No Action.	-	-	-	0	-	-	+	+	+	72 units existing residential units.
Hayes Court	10	Remove two structures in low floodplain and cul-de-sac and re-connect floodplain. Construct three to four large residential buildings on existing fill.	0	0	0	+	0	0	+	0	-	
Hayes Court	11	Remove three structures to re-connect portion of historic floodplain. Blend new fill at back of floodplain with existing fill to create elevated land for three large residential buildings out of floodplain.	+	0	+	+	+	+	+	0	0	
Hayes Court	12	Remove all structures, remove fill to re-connect historic floodplain, build two large residential buildings out of floodplain.	+	+	+	0	+	+	+	+	+	
Glen Park	13	No Action.	-	-	-	+	-	-	+	+	+	33 mobile homes, 11 lost in flood
Glen Park	14	Replace homes that were damaged during flood. Elevate fill or build flood wall to protect remaining homes.	0	-	-	+	-	-	0	-	0	
Glen Park	15	Remove fill and reconnect floodplain at sites where homes damaged.	0	0	0	-	0	0	+	+	+	
Glen Park	16	Remove all but last row of trailers at back edge of floodplain and construct larger residential building at edge of floodplain.	+	+	+	0	+	+	0	0	0	
Glen Park	17	Remove all trailers at back edge of floodplain and construct larger residential building at edge of floodplain.	+	+	+	-	+	+	+	+	0	All mobile homes in FEMA 100-year floodplain.
Glen Park	18	Re-Route Glen Street out of floodway towards back of floodplain.	0	+	+	-	-	-	+	0	0	
Mountain Home	19	No Action.	-	-	-	+	-	-	+	+	+	
Mountain Home	20	Continue channelization with berms and bank armoring to protect mobile homes.	-	-	-	+	0	-	+	-	0	Link existing berm segments.
Mountain Home	21	Remove twenty-one (21) mobile homes located in floodway of Halladay Brook and ten (10) mobile homes from floodway along Whetstone Brook to expand low floodplain.	0	0	0	0	0	0	+	+	+	
Mountain Home	22	Remove all floodway mobile homes, four (4) homes from the floodplain of Halladay Brook, and sixteen (16) homes from the low Whetstone Brook floodplain along Edgewood Drive and Woodvale Road.	+	+	+	-	+	+	+	+	+	Possible Town/State agreement?

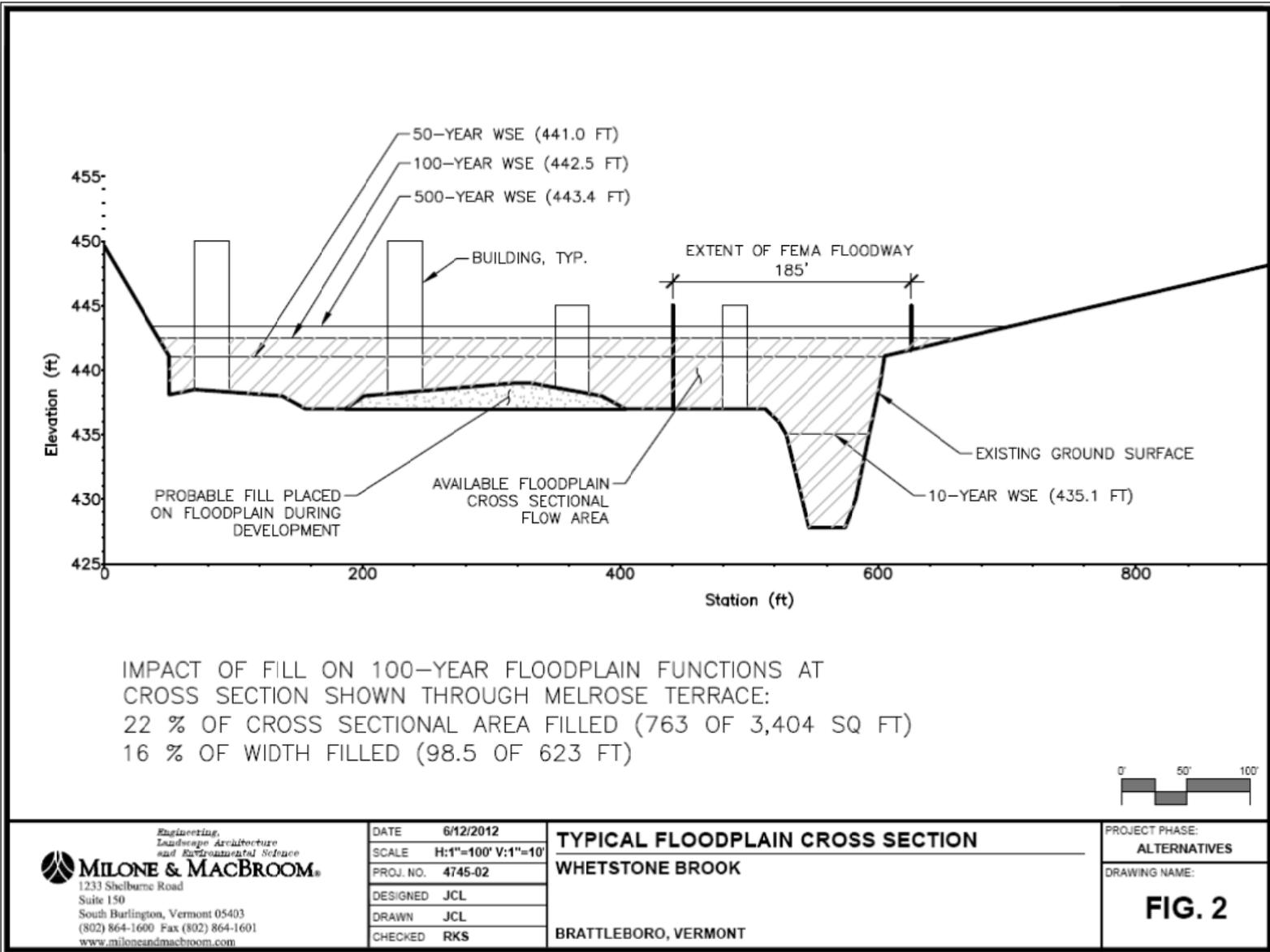
LEGEND: + good; 0 moderate; - poor

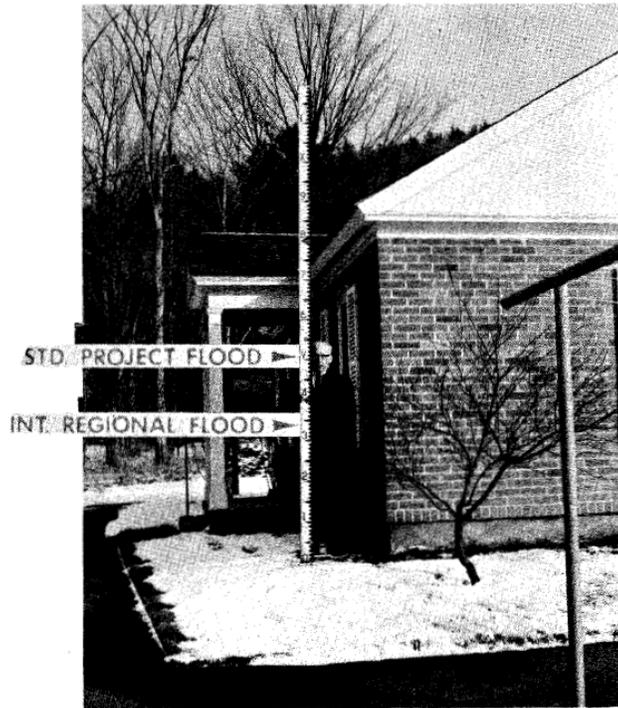


<p>Engineering, Landscape Architecture and Environmental Science</p> <p>1233 Shelburne Road, Suite 150 South Burlington, Vermont 05403 (802) 864-1600 Fax: (802) 864-1601 www.miloneandmacbroom.com</p>	Whetstone Brook Valley Walls		LOCATION: Brattleboro, Vermont	
	MMI#: 4745-02 MXD: P:\ValleyWalls.mxd SOURCE: 2011 NAIP Aerial	Whetstone Brook Alternatives Analysis		Map By: JCL Date: June 2012 Scale: see bar

Drawing: P:\4745-02 - WHESTONE BROOK\4745-02\FIGS\FIG 14 - CROSS SECTION THROUGH MELROSE TERRACE.DWG

Revised by: JCL on 6/12/2012 Date: 12 - 15:49pm



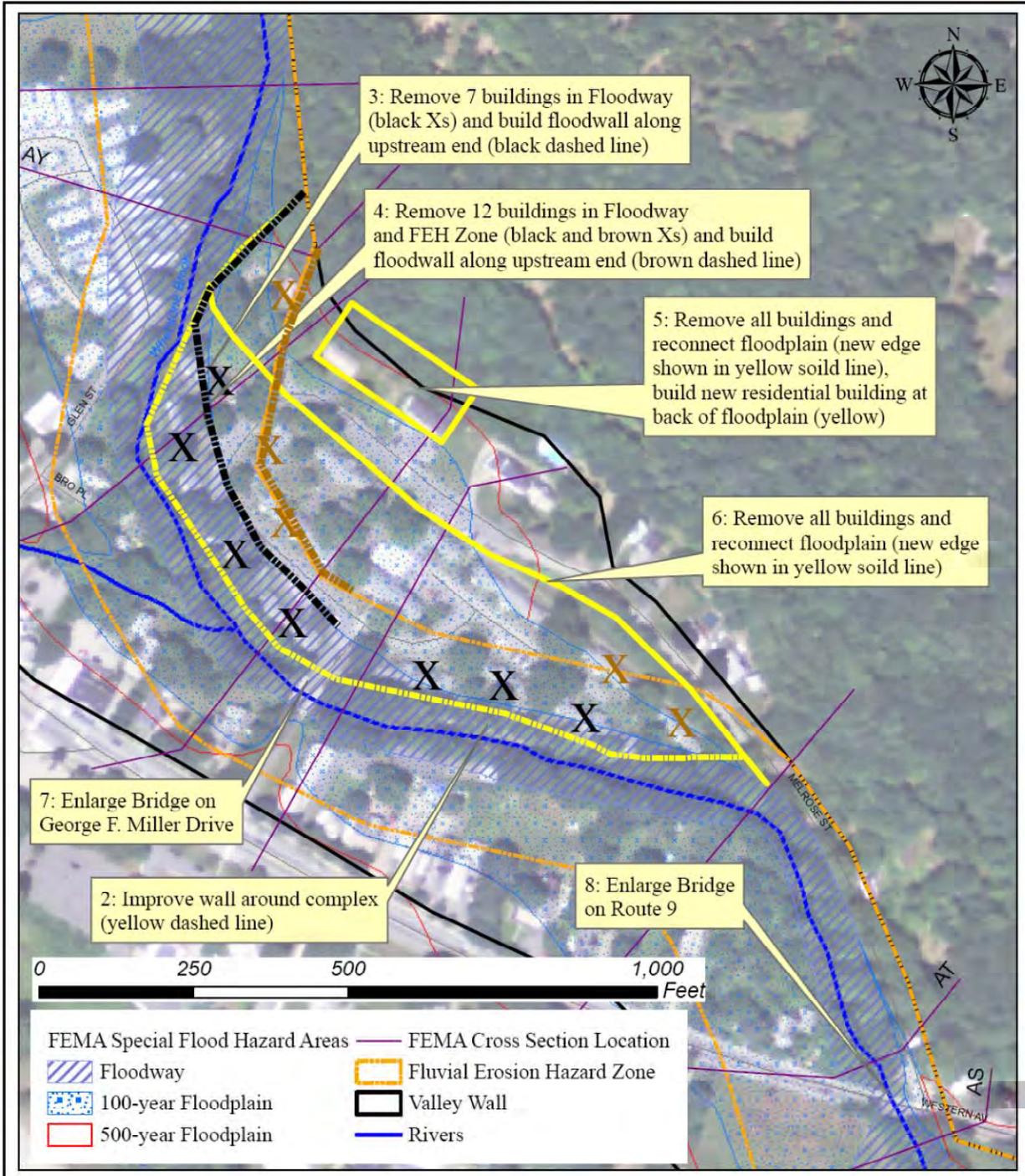


Flood Heights, upstream end of Melrose Terrace Housing Development for the Elderly, West Brattleboro.

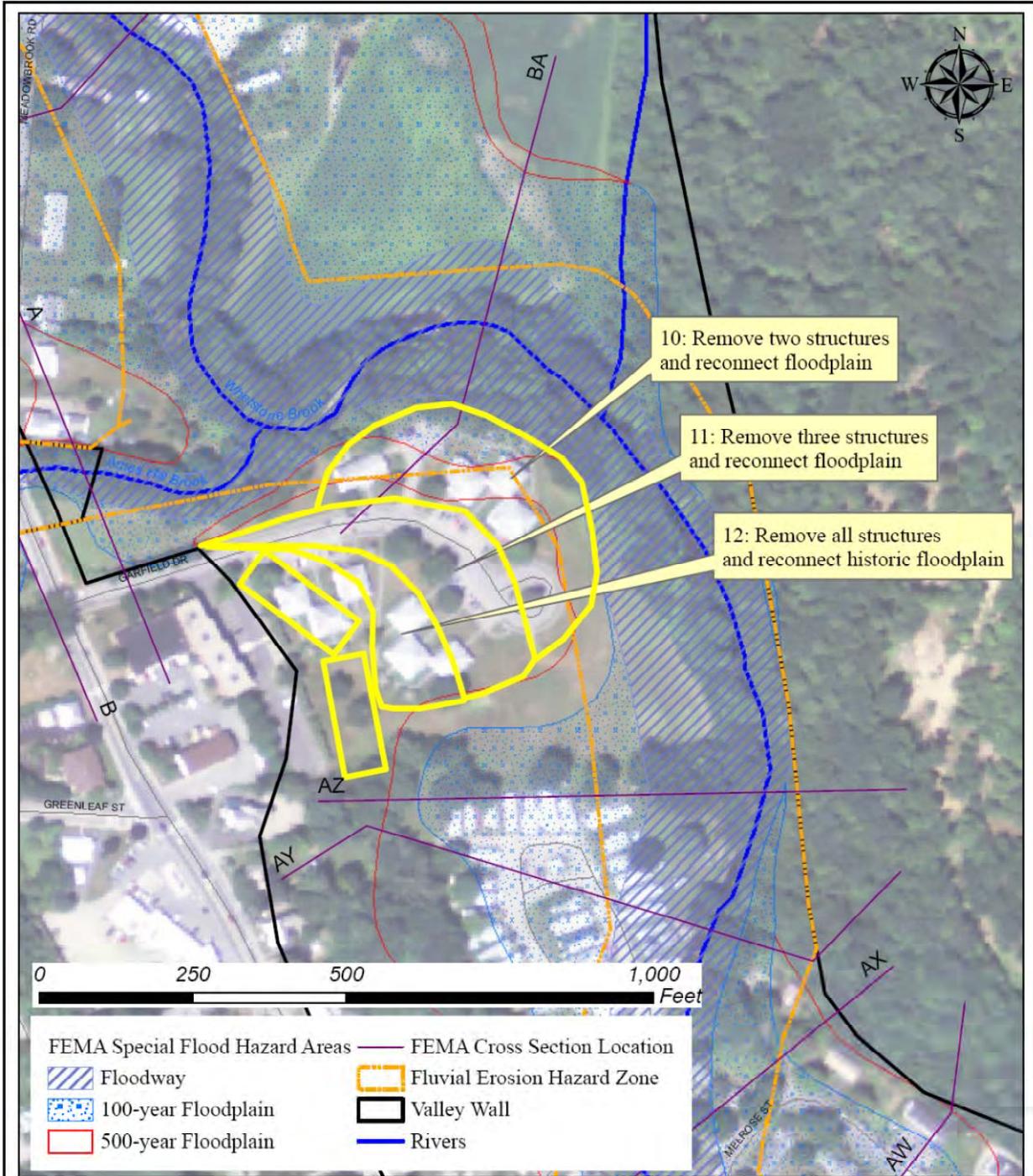


Flood Heights, mobile home in Glen Trailer Park, across Whetstone Brook from photograph above.

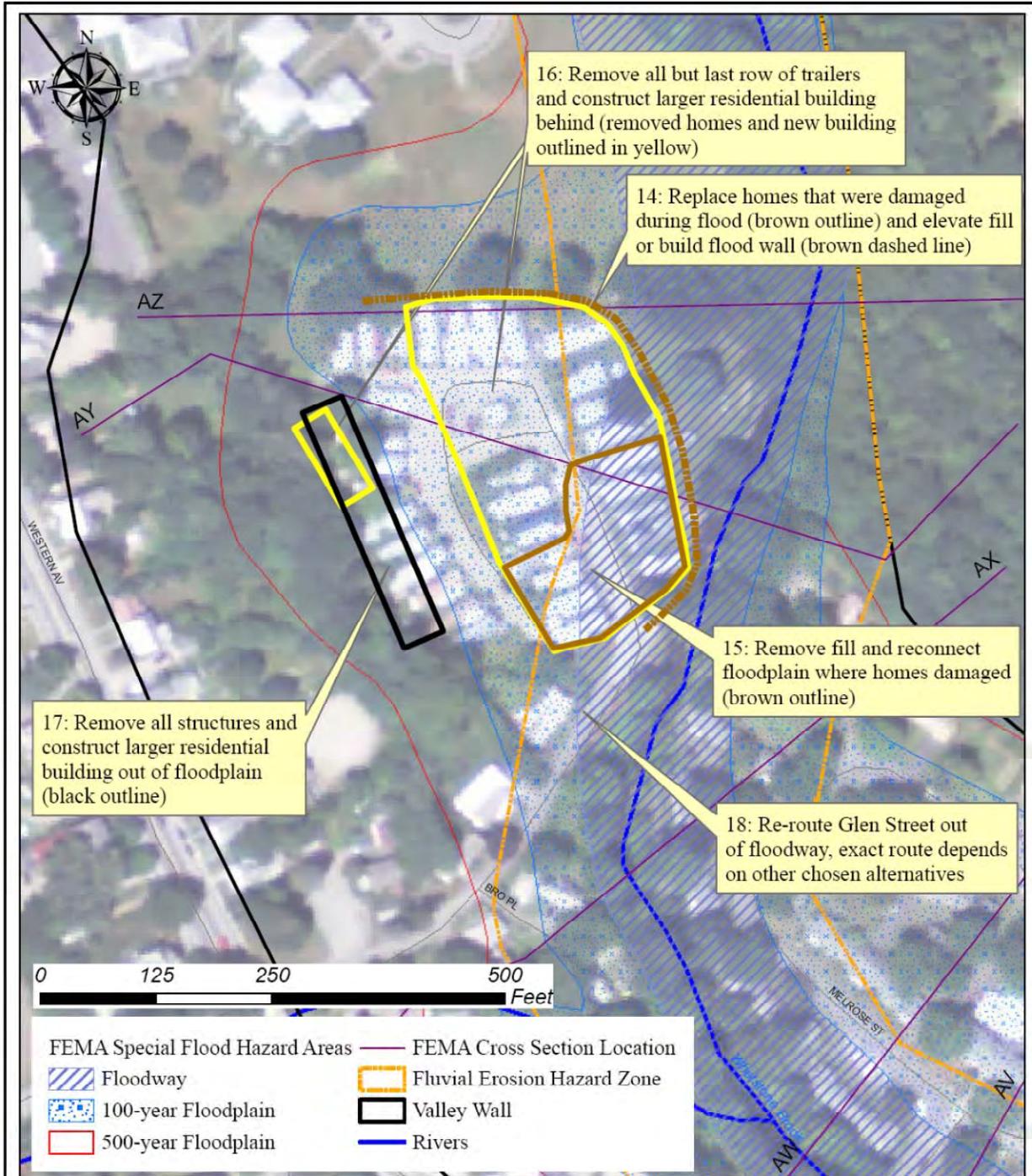
Figure 3: Predicted 100-year flood water surface (USACE, 1972).



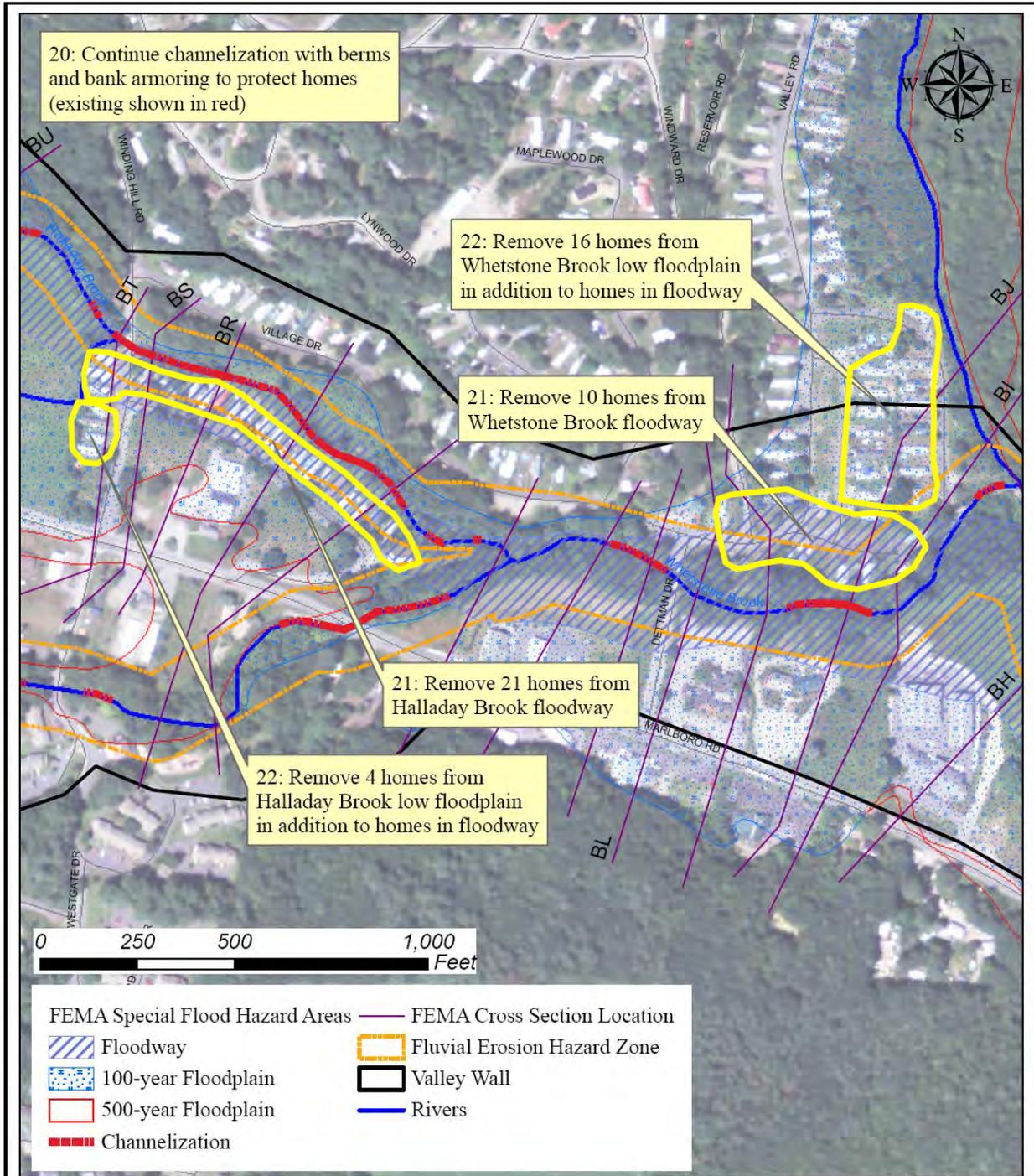
<p>Engineering Landscape Architecture and Environmental Science</p> <p>1233 Shelburne Road, Suite 150 South Burlington, Vermont 05403 (802) 864-1600 Fax: (802) 864-1601 www.miloneandmacbroom.com</p>	Melrose Terrace Alternatives		LOCATION: Brattleboro, Vermont	
	MMH#: 4745-02 MXD: P:\Melrose.mxd SOURCE: 2011 NAIP Aerial	Whetstone Brook Alternatives Analysis		Map By: JCL Date: June 2012 Scale: see bar



<p>MILONE & MACBROOM Engineering, Landscape Architecture and Environmental Science</p> <p>1233 Shelburne Road, Suite 150 South Burlington, Vermont 05403 (802) 864-1600 Fax: (802) 864-1601 www.miloneandmacbroom.com</p>	<p>Hayes Court Alternatives</p>		<p>LOCATION: Brattleboro, Vermont</p>	
	<p>MMI#: 4745-02 MXD: P:\Hayes.mxd SOURCE: 2011 NAIP Aerial</p>	<p>Whetstone Brook Alternatives Analysis</p>		<p>Map By: JCL Date: June 2012 Scale: see bar</p>

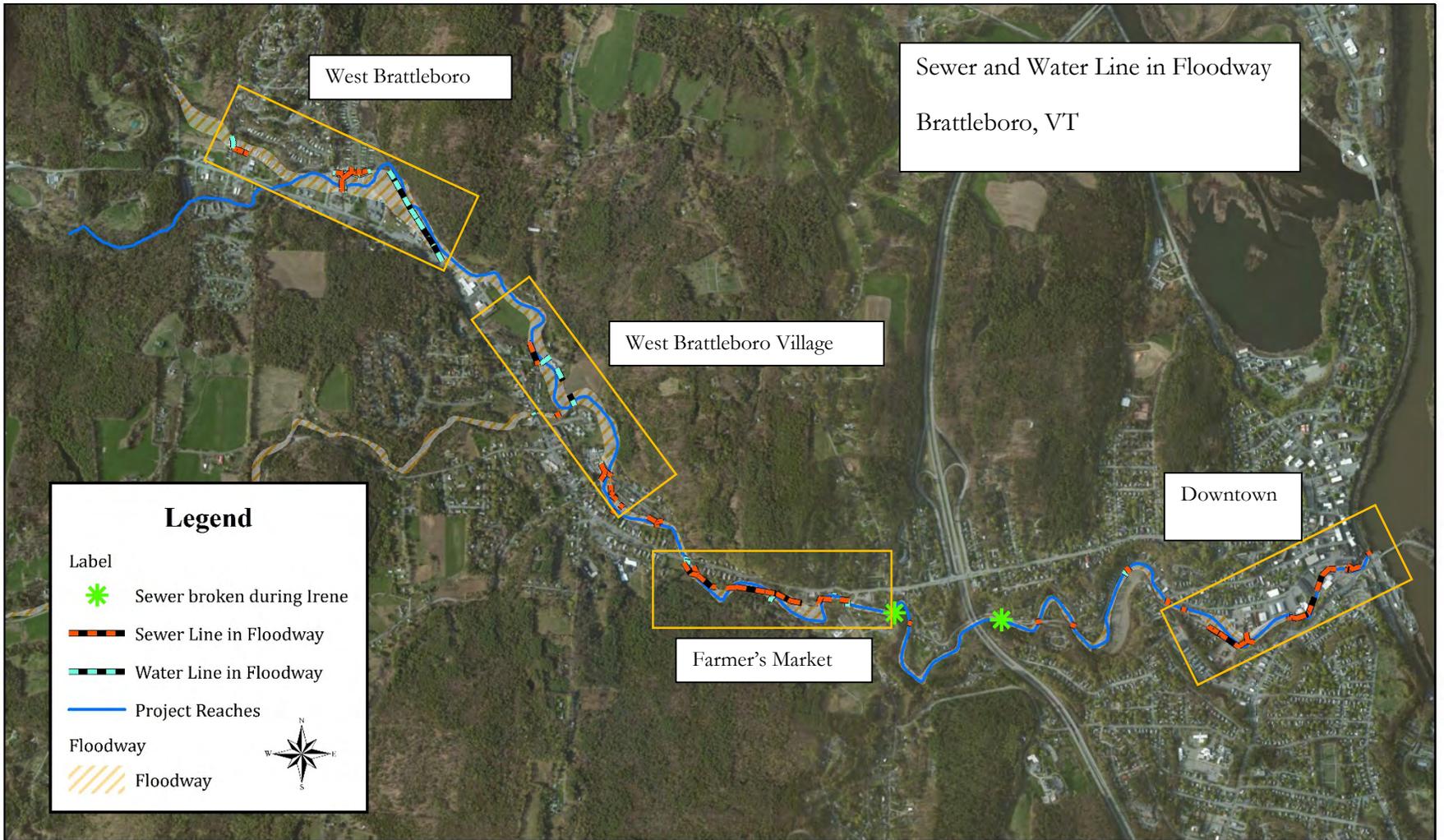


<p>Engineering, Landscape Architecture, and Environmental Science</p> <p>1233 Shelburne Road, Suite 150 South Burlington, Vermont 05403 (802) 864-1600 Fax: (802) 864-1601 www.miloneandmacbroom.com</p>	Glen Park Alternatives		LOCATION: Brattleboro, Vermont	
	MMI#: 4745-02 MXD: P:\GlenPark.mxd SOURCE: 2011 NAIP Aerial	Whetstone Brook Alternatives Analysis	Map By: JCL Date: June 2012 Scale: see bar	SHEET: Figure 6



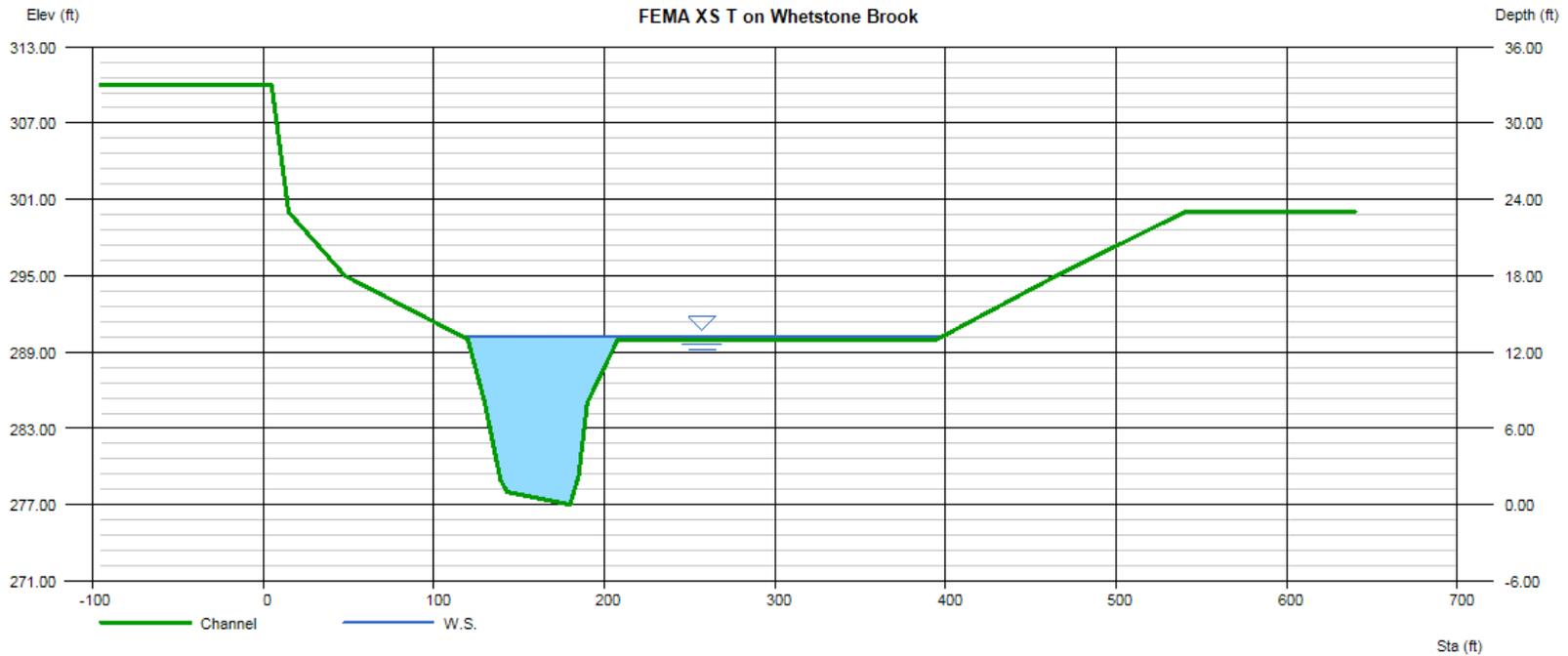
<p>Engineering, Landscape Architecture and Environmental Science</p> <p>1233 Shelburne Road, Suite 150 South Burlington, Vermont 05403 (802) 864-1600 Fax: (802) 864-1601 www.miloneandmacbroom.com</p>	Mountain Home Area Alternatives		LOCATION: Brattleboro, Vermont	
	MM#: 4745-02 MXD: P:\Mountain Home.mxd SOURCE: 2011 NAIP Aerial	Whetstone Brook Alternatives Analysis		Map By: JCL Date: June 2012 Scale: see bar

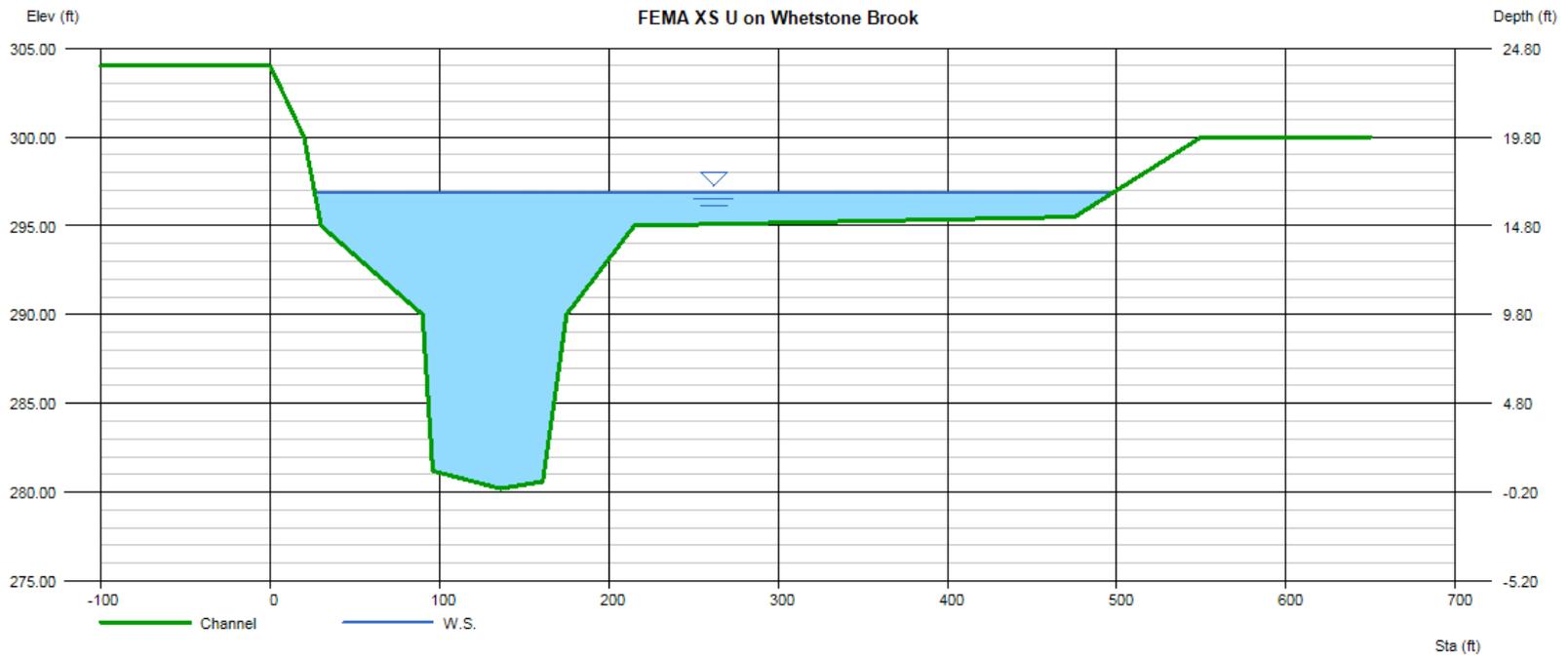
Appendix L:
Map of Sewer and Water Lines in Floodway



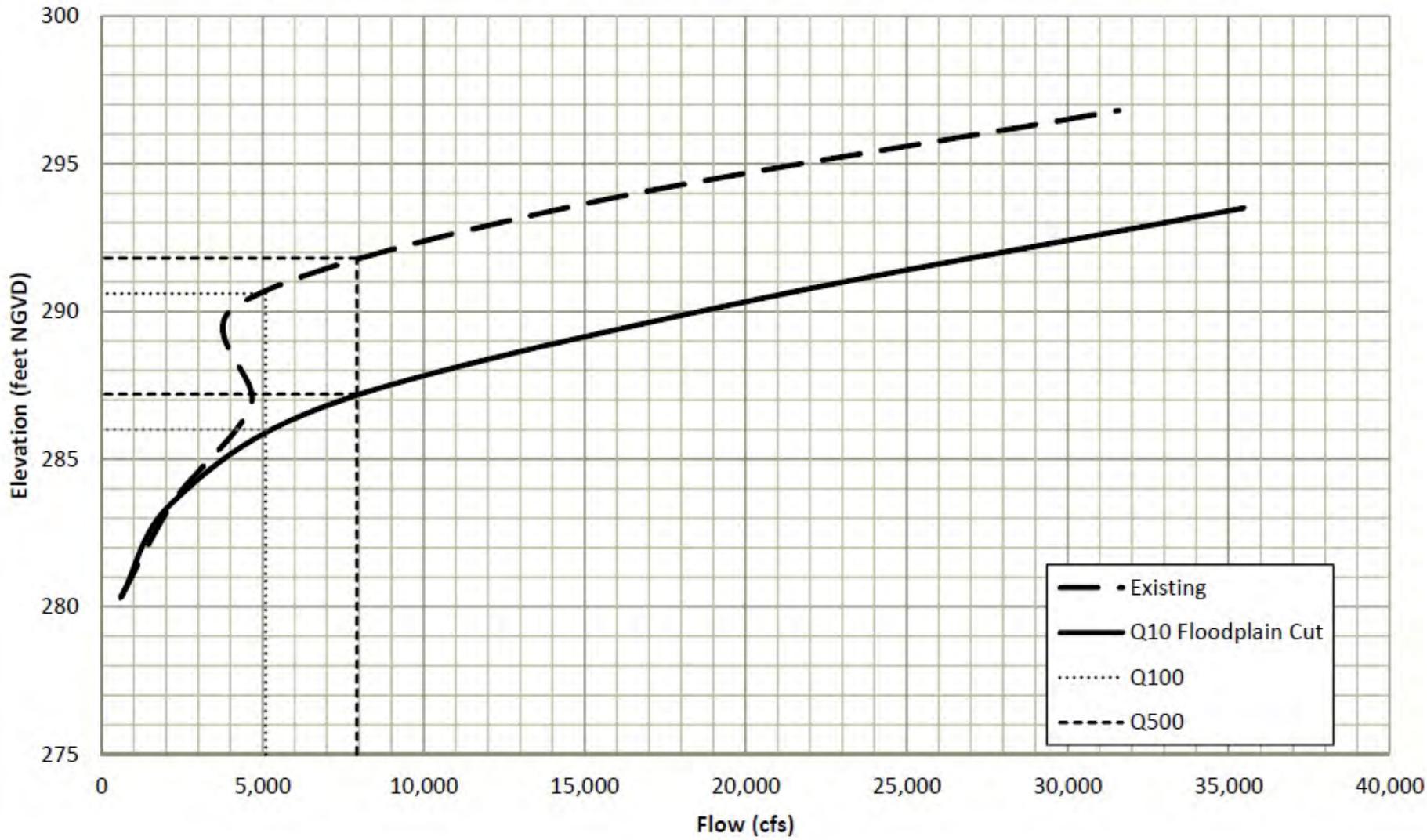
Appendix M:
**FIRM Cross Sections and Change in Flood Level for
Floodplain Restoration**

Bankfull depth is estimated to be 3-4 feet (~280') at cross section T. If the floodplain were cut to the ten year flood elevation (3,300 cfs) it would reduce local flood elevations during major storm events by 4' to 5'. Additionally the eight acres of floodplain will store 40 acre feet or 217,800 ft³ of water during 100 year floods. There will also be some upstream flood reduction with the creation of floodplain in this area. A hydrologic and hydraulic analysis is required to understand the full up and downstream benefits of the project.





Change in Local Flood Levels with Floodplain Cut (FEMA T)



Appendix N:
Community Forum Meeting Notes

Vermont Economic Resiliency Initiative (VERI)

Community Forum – Town of Brattleboro

MEETING NOTES

October 15, 2014 – 6:00 - 8:00 PM

VERI Project Overview

With funding from the [US Economic Development Administration](#) (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes.

VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open – saving jobs and maintaining our economy.

For More Information

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI

Summary

19 community members, business owners, and homeowners from the Whetstone Brook catchment area in Brattleboro attended the Vermont Economic Resiliency Community Forum. The community identified five major flood hazard risks in Brattleboro – commercial and residential development in the floodplain (around Sunset Lake Road and the Melrose Housing Development), debris catchment and bridge sizing along Bridge 35 and the Main Street and Melrose Bridges, inadequate stormwater drainage capacity, and berming along the Elliot Street Bridge and Williams Street. Successful mitigation projects in the Brattleboro have included the acquisition of Locke Field to restore the floodplain and using green infrastructure and permaculture techniques to mitigate flood water risks at the Brattleboro Food Coop, the Farmer’s Market and the Glen Mobile Home Park. Further analysis and technical assistance needs of the community emphasized a watershed approach to flood management, updated zoning regulations and standards to decrease development in the residential and rural residential zones, disaster preparedness and risk identification, business continuity of

operations planning, pervious technologies and water retention strategies, land acquisition, and active stream management to preemptively remove debris from waterways.

Present

- Residents and Business Owners: Stan Lynde and Laura D'Angelo Lynde (Lynde Motorsports), Paul Normandeau, Nori and Vic Howe, Bill and Eric Daley (Vermont Country Deli), Jon Potter (Latchis Arts, Inc.), Joe Jewett (Jewett Plumbing and Heating), Cimbria Badenhausen, Naomi Shafer (New England Youth Theater), Ra Van Dyk (Brattleboro Area Farmer's Market), Michael Bosworth (West Brattleboro Association), Deb Zak (Windham-Windsor Housing Trust), Mary Durland (Tri-Park Cooperative Housing) Drew Adam, (VT Association of Conservation Districts)
- Technical Assistance: Amy Sheldon (Landslide Natural Resource Planning), Jolene Hamilton (Windham County NRCD)
- Town of Brattleboro: Rod Francis
- Regional Planning Commission: Jeff Smith and Kim Smith (Windham Regional Commission)
- State of Vermont: Noelle MacKay (DHCD), Chris Cochran (DHCD), Wendy Rice (DHCD), Josh Carvajal (ANR), Molly Burke (VT House of Representatives)
- Media and Press: Kip Tewksbury (Brattleboro Community Television)

Introduction

Rod Francis, Planning Director, Town of Brattleboro, convened the Vermont Economic Resiliency Initiative (VERI) Community Forum in Woodstock and he introduced Commissioner Mackay from the Vermont Department of Housing and Community Development.

Commissioner MacKay welcomed everyone and thanked people for participating in a first round of community forum presently being held in five Vermont communities state-wide. The Commissioner explained that the community forums are examining ways to improve economic resiliency for natural disaster impacted communities in the aftermath of Tropical Storm Irene. Through the Vermont Economic Resiliency Initiative, the State will analyze risks to public infrastructure, alongside economic activity, river corridor and flood data, to better mitigate future flood hazards and to and to ensure businesses rebound quickly. The Commissioner provided the audience with a VERI project overview and the findings of the first two phases of the project. After her introductory remarks, the Commissioner explained that the purpose of the meeting was to collect information about risks to infrastructure and economic activity observed during Irene, subsequent risk reduction, and suggested

improvements for long-term resiliency.

Overview of the Riverine Study Area

The State has contracted with a team of river scientist and engineers to review the geomorphology (defined as the study of landforms interacting with flowing water), flood hazard risks, sediment deposition potential, and impacts to the built environment of select rivers and tributaries within each targeted VERI community. The scientists presented an overview of their work and initial observations in the river corridors at each of the community forums and provided technical assistance to the respective community throughout the meeting.

Notes

- Amy Sheldon of Landslide Natural Resources Planning discussed the river corridor study. They completed Phase 2 Stream Geomorphic Assessment (SGA) for Whetstone Brook in 2008, partnered with Windham County Natural Resources Conservation District (Jolene Hamilton); She described impacts and conflict areas in the study area between the river and the built environment.
- The corridor plan had 70 projects; The Windham County NRCD has worked toward implementation of the top “10” projects listed in the Corridor Plan with local and state partners as funding resources have been found and committed to these projects.
- The watershed is 16% developed; portions in town are 72% developed; typically, watersheds more than 10% developed are considered to be heavily altered.
- The Whetstone has a lot of ledge along the brook and the brook has been channelized/dredged. The result is the river velocity has increased but erosion is actually helping as it has increased floodplain capacity and is helping the channel to recover.

For more information:

Whetstone Brook Watershed Corridor Plan. All Geomorphic Assessment Final Reports statewide can be found here. (<https://anrweb.vt.gov/DEC/SGA/finalReports.aspx>).

Public Input

The DHCD Commissioner solicited input from forum participants with regard to flood risk and mitigation opportunities in Brattleboro. The questions posed were:

- 1) What are the hazards and risk areas in the town?
- 2) What worked structurally and what has already been done since Irene to protect infrastructure and to reduce risk to businesses?
- 3) What still needs to be addressed in the interests of long-term security and sustainability?
- 4) What information should the final report include and how should this information be presented?

Identified hazards and risks will be further analyzed in Phases 3 and 4 of VERI.

Identified Natural Disaster Hazards and Business Risks

What are the hazards and risk areas in the town?

Notes: Responses from the Public

- Irene impacted one to two percent of all structures in Brattleboro.
- The effort to repair and rebuild infrastructure in Brattleboro damaged by Irene took three years; normally that amount of work is done over 20 years by Public Works.
- *Floodplain*: Most of the upper watershed is steep; area around Sunset Lake Road has to absorb power from a lot of water; here and below along Rte. 9, was mostly floodplain and agricultural land, frequently floods, but has been developed (commercially zoned). Rod Francis noted that the town's Flood Hazard Bylaw overrides commercial zoning: new development must meet regulations but there is pre-existing development in floodway. Jeff Nugent noted a number of buildings in floodplain weren't damaged due to flood regulations requiring retrofitting during construction/remodeling.
- *Stormwater Drainage Systems*: Flash flooding, even from typical summer rainstorms, common due to outdated storm water systems which cannot adequately handle the volume of water.
- *Flat Street*: Flat Street is a low point along the brook and the grade of the street was raised which causes flooding to Lynde Motorsports. Flat Street also receives floodwaters flowing downstream from the form dry kiln along the brook all the way to Connecticut River.
- *Berming*:
 - Approximately 6 acres of floodplain was filled upstream of Elliot Street bridge (south side, former Dry Kiln storage areas) because the brook was bermed here, impeding free water flow. The floodwaters created new channel through there and re-entered

the brook across from Whetstone Arts Building, which was damaged. The berm had to be re-built after Irene.

- There are concerns about Williams Street suffering more damage in future storms because of berming.
- *Bridges:*
 - Main Street Bridge: Debris catches here because the bridge is narrow and the water has to flow around an “S” curve. Water back flow affected the Wilder Building near here during Irene. The brook also has the remnants of a concrete dam at this location. It is unclear if this dam is hindering or enabling water flow. Some of the concrete in the channel does protect the Whetstone Interceptor (sewer pipe that runs in and along the Whetstone).
 - Area near Bridge 35 in Williams St (just above West St): creates separate channels after spring floods; after Irene debris built up and area was dredged; concern that the channel is very narrow here and floodwater could take out bridge; also old dam in this vicinity (but believed to be mostly gone).
 - All bridges upstream of and including Rte. 9 Bridge by Melrose Street are undersized. If Melrose Bridge goes, it will affect all of Rte. 9 west. That bridge carries 16,000 vehicles per day (state bridge on Class 1 town highway). What is the condition of this bridge?
- *Wastewater treatment:* Sewer pipe torn open below I-91 Bridge, and trestle carrying pipe across brook at head of Williams St damaged, breaking pipe.
- *Housing:* Melrose Terrace housing (includes elderly and low-income housing) buildings are located in floodway. Should the structures be removed and the floodplain restored? Note separate public discussions are occurring on this issue.
- *Debris removal:* Private landowner had 15 truckloads of debris removed from Halladay Brook; paid for with private funds but was performing a public service; can the landowner be compensated in any way?

Effective Hazard Mitigation and Risk Reduction

What worked structurally and what has already been done since Irene to protect infrastructure and to reduce risk to businesses?

Notes: Responses from the Public

- The acquisition of Locke Field (below Sunset Lake Road and behind Chelsea Royal Diner) has helped to conserve the floodplain. This was one of projects listed in SGA/corridor plan.
- No mobile homes remain in floodway at Glen Park. Irene destroyed the homes and/or homeowners removed the homes and pads. The total cost of Irene to the park was about \$314,000; all of this money came out of the resident's pockets (cooperative mobile home park). The homeowner's association restored the area, re-contouring one acre to restore the floodplain. The cost of the rehabilitation was \$25,000 paid for by cooperative homeowner's association. The association is also in the process of developing a mitigation plan and has had some consultant help for this. There is an ongoing need to relocate about 40 mobiles along brook for safety, but there is a lack of affordable housing elsewhere. The homeowner's association also contracted for a spray foam insulation to replace wet insulation on the mobiles.
- Brattleboro food coop project: designed with flooding in mind, storm water improvements using green infrastructure, parking lot, old building removed etc.
- Farmer's Market: up and running the following Saturday; grassed areas were relatively unaffected, but gravel areas damaged; stream bank restoration has been going on in the area.
- Branding and Economic Redevelopment: How do you breathe life into the economic fabric of the community after losing this economic base? VT Downtown Action Team looked more at the branding and marketing side of economic redevelopment in Brattleboro.

Resiliency and Sustainability Planning

What still needs to be addressed in the interests of long-term security and sustainability?

Notes: Responses from the Public

- *Watershed Approach*: Need to look at the watershed as a whole to limit/reduce run-off upstream. Important to educate landowners to think about diffusing and draining water up-stream properties, through techniques such as permaculture.
- *Regulations and Zoning*: Update and revise subdivision and zoning regulations. Town looking at reducing allowed density in Residential and Rural Residential districts (most of far west end up town, upper watershed); trying to minimize roads, driveways, etc. and creating recommendations for constructing them to be flood resistant; looking at benefit cost analysis

to see cost and risk for emergency response services and to help steer how development should happen.

- *Resiliency Planning:*
 - Town can also develop response and resiliency strategies (such as identifying choke points, and understanding the economics of the choke points etc.)
 - Do long term resiliency planning using California's earthquake approach that integrates building codes/protocols and education (e.g. secure oil/propane tanks). Flooding is "normal;" it's going to happen again, and need to Ingrain principles of risk aversion and recovery management in Vermonters.
- *Business Continuity:*
 - Need to educate businesses and individuals to create a disaster preparedness plan; e.g. continuity of operations plan for businesses; need to know what they do to prevent damage, and practice strategies so they know how to use the plan.
 - What incentives should be used to get businesses to create a plan? What should be done to reach businesses? Require continuity of operations plans when applying for grants, assign outreach/case workers to businesses to explain the benefits of a COOP plan, Use VT Small Business Development Center, Chambers of Commerce, BDCC, Rotary, Downtown Alliance as outreach resources.
 - Case workers for businesses are needed: help with their long-term goals; should they close? Sometimes it is better to save the entrepreneur than save the business.
 - Business plans could include diversification, e.g. developing an on-line component etc.
 - Need to think about "interim operations" for businesses to operate in if they have lost their main physical location (e.g. a temporary location- Building? Food truck? "Pop-up" shops? Shipping containers?). For example, after Irene you couldn't find a cup of coffee in downtown Wilmington, the Green Cup in Waitsfield shifted to a temporary space. Could we plan for this? Could do inventory of vacant spaces, may need changes in zoning rules (applicable zones, business permitting, duration of permit; application process). Would need to pre- identify how to procure portable pop-up units (such as shipping containers) and how to connect them to utilities. Ideally each community would have a designated point person to set these up in an emergency situation. (Comparative example: Christchurch, NZ - <http://www.youtube.com/watch?v=R3NyfO4PRAg>).

- *Impervious Surfaces:* Minimize impervious surfaces especially in the downtown area. Look at Arizona for examples of how they are responding to extreme weather events or to St. Albans which did a flower garden water retention on Main St. and Taylor Park.
- *Housing:*
 - To benefit affordable housing and economic development: have a high density leased land housing cooperative.
 - Efficiency Vermont, Vt. Housing and Conservation Board, and High Meadows Fund developed Vermods, a modular unit that is being accepted across the state; same space requirements as a mobile home. Proposal: high density, leased land, energy efficient, maybe home built, using local lumber, designed locally (like First Day cottage/tiny house). But need more builders involved.
- *Education:* Need to teach business owners about new types of construction and the cost/benefit of “alternative infrastructure” and new technologies, to increase willingness to try innovative approaches; e.g. pervious concrete.
- *Emergency notification:* Improve notification of residents and businesses; we already have VT Alert <http://vtalert.gov/> ; need to change the culture of people to listen to alerts, could use children as emissaries for this message.
- *Information Dissemination:*
 - Do information dissemination after event in multiple waves – people need psychological recovery before they can process information. Recovery takes years. Replicate outreach every few months.
 - Brattleboro has a business license system- helps maintain a database of all businesses, to plot in GIS, and to help determine risk.
 - After Irene, state agencies all took in economic data, but processed through distinct/separate systems. Data collections is now centralized to help track impact to businesses and homeowners over the continuum of recovery.
- *Acquisitions:*
 - Need to invest more in buy-out program (if building is repetitive loss, property is purchased and cleared), and try to do it pre-disaster; a lot of money upfront, but good mitigation effect later; Brattleboro has good records of flood loss going back to 1974, but process can be difficult—often difficult to get benefit/cost numbers to work; very few actual repetitive loss properties in VT, impacting opportunities for FEMA money.

- Housing Conservation Fund- could this be used to create contiguous flood plain tracts of land?
- Stream management: Keeping streams debris free is critical. Obvious issues up along Route. 9. Does the state have a management program to clear debris, logs etc.?

Information Sharing and Dissemination

What information should the final report include and how should this information be presented?

Notes: Responses from the Public

- Commissioner Mackay noted that recommendations and ideas will be incorporated into a draft report, and a second community forum will be held in January to review report and present some solutions.
- The report needs details on how the stream is changing, what impacts a project will have on neighboring properties, it should not emphasize engineered solutions natural river flow and whole watershed management approach.
- The report needs to be concise with a one to two page executive summary.
- Include information on how watersheds work, similar to stream geomorphology handout at forum. Model how the stream would look if the floodplains were restored as per the corridor plan.
- Change peoples' thoughts about keeping, retaining flood water on their upstream properties
- A schematic that shows how individual community members can mitigate their risk on their personal properties. Whetstone rises and falls more quickly after Irene → additional support for this recommendation.
- Let people know how often they can expect a major flood event to incentivize them to become more resilient. A "100-year" flood has a likelihood of happening every 12 years.

Vermont Economic Resiliency Initiative (VERI)

Community Forum - Brattleboro

MEETING NOTES

April 20, 2015 – 7:00 – 9:00 PM

VERI Project Overview

With funding from the [US Economic Development Administration](#) (EDA), the Vermont Department of Housing and Community Development, working with the Agencies of Natural Resources and Transportation and the Regional Planning Commissions, launched the Vermont Economic Resiliency Initiative (VERI) to help ensure Vermont remains open for business when disaster strikes. VERI will help the state and local communities by evaluating local flood risk to business and infrastructure, and identify the steps communities and the state can take to minimize rebuilding and recovery costs and ensure businesses stay open – saving jobs and maintaining our economy.

For More Information

http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI/Brattleboro

Summary

Twenty-five people were in attendance, including project team members, town officials, state officials, state representatives, and landowners, community members, and business owners from the Whetstone Brook. The forum showcased five high-priority projects and four policy and program recommendations which could significantly decrease flood risk for Brattleboro, if implemented. Community members were given the opportunity to ask questions, provide input, and rank the proposed projects. The projects which the community most supported included conserving the eight acre parcel just upstream from downtown, and removing the sediment plug under the Williams Street Bridge. Buyouts of at-risk properties also ranked high. The policy and program recommendations which the community most supported included regulating new development in both the flood hazard area and in fluvial erosion hazard areas. Continued participation in FEMA's Community Rating System and seeking a higher rating (to reduced flood insurance rates) also ranked high.

Welcome and Overview

[Noelle MacKay, Commissioner of the Department of Housing and Community Development]

Noelle MacKay began by going over the agenda for the evening and emphasized the importance of community input on the proposed flood reduction projects. Starting off with the “big picture,” Noelle said the Vermont Agency of Commerce and Community Development’s role after Irene was post-disaster recovery and noted that while Irene impacted buildings and infrastructure, it was also a tremendous blow to the State’s economy. The state applied for and received a grant from the US Economic Development Authority to help five Vermont communities build back stronger and take steps to protect their economy from future floods.

Noelle introduced the project team members and provided background information on a successful project in [Bennington](#) that created the model for this project. She also explained the process for selecting the five towns – each with high flood risk to economic activity and infrastructure.

Brattleboro was selected as a VERI pilot community because it is a state-designated downtown, is ranked number four of communities in Vermont for economic activity, and number six in terms of infrastructure vulnerable to flooding. Also because the community has made progress on flood resiliency planning, it successfully implemented a number of projects to reduce flood risks and it had a stream geomorphic assessment of the Whetstone Brook.

As part of this project, a team of river scientists and engineers were hired to further assess the Whetstone Brook, identify local threats to infrastructure and business and make recommendations to reduce the impacts of future floods.

The first Brattleboro Community Forum was held in October 2014, where Noelle sought input from attendees on three topics: what did they see happen during Irene, what have they done to prepare for the next flood, and what would they like state government, the town, and other agencies and organizations to do to help the community prepare for the next flood?

The VERI team combined this information and its analysis into a draft report that contains recommended projects and town-wide policy and program options to reduce flood risks. The projects were ranked by the consultants on whether they are effective, limited, or ineffective at reducing erosion risk, flood risk, and damage to businesses, infrastructure, and property. The ease of implementation, cost, and potential partners are also a factor.

Noelle stressed that this is a draft report, and that the team is eager to get comments from the public. The report will be up on the project web site until May 4th. She believes the report can serve as a road map for the community and provide a menu of options for what can be done to help protect the community. She noted that putting these projects into Brattleboro's Hazard Mitigation Plan is a good way to help fund them. The Agency of Commerce and Community Development will work with partners to help identify funding sources once priority projects are identified.

Overview of Municipal Policies and Programs to Reduce Future Floods

[Jeff Nugent and Alyssa Sabetto, Windham Regional Commission]

Before presenting policy and program recommendations for the community, Jeff Nugent first noted some of the Town's accomplishment regarding flood resiliency. Brattleboro has three full-time planners on staff, and he worked with them on a number of issues post-Irene. The town plan identifies a number of important flood and erosion hazard goals. Brattleboro is one of only three communities in Vermont to be part of FEMA's Community Rating System, which not only recognizes the Town for their efforts in the National Flood Insurance Program and lowering flood risk, but also results in reduced flood insurance premiums for landowners. Jeff noted that a number of projects listed in the town's previous hazard mitigation plan have been completed, and that Brattleboro worked with the Vermont Downtown Action Team on efforts to speed economic recovery post-Irene.

Alyssa presented information on the Emergency Relief Assistance Program noting that Brattleboro has completed steps to receive a state aid rate of 12.5%. She listed the next steps required to increase this state aid to 17.5%.

Jeff then discussed specific policy and program recommendations developed by the team. Some of these recommendations are not easy, and not without controversy, and are presented to promote discussion. Four recommendations were considered high-priority by the team.

Alyssa spoke on the Community Rating System, and the recommendation that Brattleboro achieve a higher rating. Jeff presented three other recommendations:

- Identify areas for conservation (both the Whetstone and Crosby Brook corridor plans list such sites; conserving them reduces future development in flood-prone areas and allows natural stream functions to continue);
- Regulate development in fluvial erosion hazard areas (current regulations are directed at flood inundation areas, but may not be effective for erosion hazards); and,

- Regulate grading and clearing on slopes greater than 15% (keeping these areas vegetated and undeveloped helps reduce floodwater and erosion).

Overview of Project Recommendations and Conceptual Designs

[Amy Sheldon, Landslide Natural Resource Planning, Inc.]

Before her involvement with the VERI project, Amy worked on the Whetstone Brook's Stream Geomorphic Assessment and River Corridor Plan, which was completed before Tropical Storm Irene. She visited immediately after the storm and toured the watershed with Brattleboro Town Planner, Rod Francis, to see the impacts.

Amy then provided some background on the watershed. First, she explained the terms floodway, floodplain, fluvial erosion hazard area, and river corridor. Second, she noted that 40% of the project area's floodplain and floodway is developed; for just the floodway alone, development is 18%. These numbers are quite high.

The team identified 18 site-specific projects and divided them into four categories: Building and Site Improvements, Channel and Floodplain Management, Infrastructure Improvements, and Public Safety Improvements. Five high priority projects were detailed and some had conceptual plans to help secure future grants and funding for implementation.

1. Conserve 8 Acres of Floodplain Upstream of Downtown (Channel and Floodplain Management):

Amy described how during Irene, the Whetstone Brook accessed the floodplain by breaking through a berm, and creating a flood channel through the site. The plan here is to excavate the area so that it would flood more frequently, and potentially reduce base flood elevations by 4-5 feet downstream. This is a very significant reduction. By conserving the parcel, there is the added benefit of preventing runoff from new development, and by preventing further restrictions to the brook accessing the floodplain.

Notes and Responses from the Public: This parcel could be a resource for the community, perhaps in the form of an edible landscape. Amy noted that the soils here are mostly gravel.

2. Williams Street Bridge (Infrastructure Improvement):

The bridge itself is a long span—103 feet—with a center pier. This is greater than the bankfull width. However, half of the span is filled with sediment, and this sediment plug reduces the effective flow of

water. The proposed project is to remove the sediment to allow more water flow during flood events, thereby lessening potential damage to the bridge. This is a relatively easy and inexpensive project.

Notes and Responses from the Public: 1) Many large rocks were removed from the Brook just upstream of this bridge following Irene. 2) Is there any economic value in the material being removed? Amy noted that there could be, but it's somewhat dependent on timing. If someone needs material at the time of removal, then certainly. A participant noted that these river materials may be appropriate for town roads.

3. Route 9 Bridge by Cumberland Farms (Infrastructure Improvement):

At this location, the brook and the bridge (or both) are not properly aligned. While the bridge is in good shape, the misalignment results in severe erosion to the bridge. Historically the brook was straightened in this area, and it's now trying to regain its meanders. Amy noted there is an existing flood chute with no buildings that could be reopened to better align the water flow and reduce risk to the bridge.

Notes and Responses from the Public: Reopening this flood chute would straighten the brook, which conflicts with state guidance to allow rivers to move and reestablish their meanders. Implementing this change would increase the velocity of floodwaters downstream of the bridge with unknown consequences. Amy noted that yes, this seems to go against conventional thinking, but it is balance between protecting existing infrastructure and river science. Noelle thanked the participant for bringing this up and said this point will be acknowledged in the final report.

4. Floodproof or Relocate Sewer and Water Lines (Infrastructure Improvement):

There are four main areas where water and sewer lines are located in the floodway: downtown; near the Farmer's Market, in West Brattleboro village, and out near Marlboro Road. The lines cross the brook and either run in the brook or alongside of it. In total, 8,445 feet of sewer pipe and 4,881 feet of water line are at risk. There were two sewer line breaks during Irene.

Notes and Responses from the Public: 1) The sewer pipes may be leaking. Rod noted that they would need to put a camera in to look for leaks. One business in West Brattleboro that was a big source of sewage in the brook is now closed. 2) What is the age of the sewer pipe, and what is its expected lifespan? Rod noted that most of the sewer lines in the Whetstone were installed in the 1950s and may be at the end of their reasonable life. All throughout

town, however, the water and sewer lines may be quite new, or very old; and some are still wood.

5. Consider Buyouts or Relocation Strategies for At-Risk Properties (Public Safety):

This is acknowledged as being expensive and complicated, but it will increase floodplain capacity and get people out of harm's way. The primary properties at risk are mobile home units.

Notes and Responses from the Public: 1) If mobile home units are removed from Glen Park, the road will still be in the floodway. Amy acknowledged that the road should and could be moved out of the floodway to provide access to the remaining units. 2) Every home that's removed in Mountain Home and Deepwood increases the bond payment (for the water and sewer infrastructure) for those who remain. Rod noted that these financial issues need to be resolved, and that relocation funds could be used to address this issue as well. Noelle added that this needs to be acknowledged in the report, and the needs of the people, the risk of the location and mobile home park's business model needs to be considered. Rod added that Brattleboro Housing Authority is ready to break ground on the 55-unit Red Clover Commons, which will accommodate residents relocated from the floodway at Melrose Terrace. At Melrose, twenty units will remain on-site, along with offices and maintenance buildings.

Where to Get Help

[Noelle MacKay, Commissioner of the Department of Housing and Community Development]

The program and policy changes, along with the site-specific project, are directed at the community as a whole, including town government. Noelle shifted the discussion to what individuals can do address flooding.

She noted a number of case studies (available in the back of the room and online) that highlight mitigation measures on existing buildings, including historic buildings. One of these case studies documents the floodproofing of the New England Youth Theater in Brattleboro. Another case study shows how a historic home was floodproofed. The perception is that not much can be done to flood proof old buildings, but this isn't true. Grants for these types of projects don't commonly go to individuals, but Noelle said they will be looking into some creative funding sources for projects that involve businesses and individuals.

Noelle talked about the Brattleboro VERI web page, ACCD's Flood Resiliency web page, and the Flood Ready web site. Vermont's Small Business Development Center was also mentioned, especially their disaster recovery guide for businesses. FEMA is also planning to present a training on small business recovery in September, and the upcoming Vermont downtown conference will feature a session on floodproofing by local engineer Bob Stevens.

Notes and Responses from the Public: It's important to remember that when we are talking about "businesses," we are talking about non-profits as well. It's important that non-profits understand that these resources are available to them as well.

Project, and Policy and Program Prioritization

Sticky dots were handed out for people (six each) to place on the charts to prioritize project recommendations, and policy and program recommendations, in Brattleboro. The town's ranking of the high priority projects can help the town advance projects. Before ending the presentation, Noelle thanked everyone for coming, especially those who participated in the VERI forum for the second time.

The results of the project prioritization are below, in order of popularity - with number of sticky dots received in parenthesis.

1. Conserve 8 acres of floodplain and remove berm owned by Cersosimo Lumber upstream of downtown. (12)
2. Remove channel blocking sediment upstream of the downstream Williams Street Bridge. (9)
3. (tie) Remove sewer and water lines within the river channel at locations throughout the project area. (5)
3. (tie) Protect remaining undeveloped floodplain (7 acres south + 5 acres north of Whetstone Brook). (5)
3. (tie) Consider buyouts for at-risk properties; site 6. (5)
3. (tie) Work with businesses to decrease impervious surfaces and install rain gardens/green infrastructure. (5)
4. (tie) Consider buyouts for at-risk properties; site 4. (4)
4. (tie) Preserve existing undeveloped wetland corridor. (4)

The results of the policy and program prioritization are below, in order of popularity - with number of sticky dots received in parenthesis.

1. (tie) Consider prohibiting new development in mapped flood hazard areas. (9)
1. (tie) Consider prohibiting new development in fluvial erosion hazard areas. (9)
2. Continue to participate in the Community Rating System and work to achieve a higher rating.
(5)
3. (tie) Educate landlords and contractors about flood resilience. (3)
3. (tie) Hazard Mitigation Plan goals should consider development of green infrastructure. (3)
3. (tie) Document damages from flood events. (3)

Vermont Economic Resiliency Initiative [VERI]

Consultant Team



Fitzgerald Environmental Associates, LLC.

Applied Watershed Science & Ecology



MILONE & MACBROOM

*Engineering, Planning,
Landscape Architecture
and Environmental Science*



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