LOCAL FLOOD ANALYSIS

TOWN OF LEXINGTON ALONG SCHOHARIE CREEK AND THE WEST KILL
IN THE HAMLETS OF LEXINGTON AND WEST KILL
GREENE COUNTY, NEW YORK

MAY 2016

MMI #2884-03

Photo Source: Milone & MacBroom, Inc. (2014)

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Prepared by:

MILONE & MACBROOM, INC.
231 Main Street, Suite 102
New Paltz, NY 12561
(845) 633-8153
www.miloneandmacbroom.com

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ABBREVIATIONS/ACRONYMS

BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
BFE	Base Flood Elevation
CFS	Cubic Feet Per Second
CRS	Community Rating System
CWC	Catskill Watershed Corporation
DFIRM	Digital Flood Insurance Rate Map
DMA	Disaster Mitigation Act
EWP	Emergency Watershed Protection
FEMA	Federal Emergency Management Agency
FIA	Flood Insurance Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
GCSWCD	Greene County Soil & Water Conservation District
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center – River Analysis System
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
LFA	Local Flood Analysis
LiDAR	Light Detection and Ranging
LOMR	Letter of Map Revision
MMI	Milone & MacBroom, Inc.
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act
NRCS	Natural Resources Conservation Service
NYCDEP	New York City Department of Environmental Protection
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York State Department of State
NYSDOT	New York State Department of Transportation
NYSEMO	New York State Emergency Management Office
PDM	Pre-Disaster Mitigation
PMR	Physical Map Revision
RFC	Repetitive Flood Claim
SFHA	Special Flood Hazard Area
SMP	Stream Management Program or Stream Management Plan
SRL	Severe Repetitive Loss
T	Trout
TMDL	Total Maximum Daily Load
TS	Trout Spawning
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WI/PWL	Waterbody Inventory/Priority Waterbodies List
WHO	West of the Hudson River

Executive Summary

The Local Flood Analysis (LFA) contained herein for the Town of Lexington demonstrates that several flood mitigation projects have merit because they reduce flood water surface elevations in Lexington Hamlet near the intersection of Route 42 and 13A. These projects largely depend on the construction of a lower floodplain (referred to as a floodplain bench) coupled with replacement of the Route 42 bridge over Schoharie Creek and a handful of strategic building removals to facilitate the floodplain bench creation.

A similar combination of flood mitigation projects such as floodplain benches and bridge replacements is not feasible for reducing flood risk in West Kill Hamlet.

Individual property owners will be required to elevate or floodproof their properties over time as substantial damage or substantial improvement thresholds are triggered. Owners in strategic locations may wish to pursue optional elevations and floodproofing where unacceptable flood risk remains after floodplain and bridge replacement projects are implemented. This will have the dual benefit of reducing flood risks while reducing flood insurance premiums for those properties that are insured.

Creation of extensive floodwalls and levees is not supported by this LFA, nor is extensive sediment removal from the rivers. Widespread removal of buildings from either hamlet is also not supported by this analysis as the community would suffer from the disruption to its population centers and loss of tax base.

The following flood mitigation alternatives are recommended and are further detailed within this report:

1. Proceed with comprehensive flood mitigation in Lexington Hamlet center through the projects described in this LFA:

    - acquire and remove home on south side of Route 13A
    - acquire and remove Lexington Hotel
    - lower the sewer pipe between Route 13A and Schoharie Creek
    - create floodplain bench
    - replace Route 42 bridge

2. Consider and pursue flood mitigation for properties along Route 23A and Banks Road where backwater conditions extend from Schoharie Creek through culverts under Route 23A, causing tributaries to flood in the vicinity of these culverts. Mitigation may include property-specific options (elevations) and conveyance/backwater mitigation projects.

3. Pursue property-specific flood mitigation options in Lexington Hamlet near West Kill Creek. The choice of acquisition vs. elevation will depend on the position of each building relative to the West Kill Creek floodway.

4. Pursue property-specific flood mitigation options in West Kill Hamlet near West Kill Creek. The choice of acquisition vs. elevation will depend on the position of each building relative to the West Kill Creek floodway.

5. Consider elevation of homes on a case-by-case basis as property owners approach the Lexington Flood Commission and/or the Town about mitigation. Ensure that elevations are conducted in accordance with the effective BFE at the time of the work.

6. Consider and pursue stream stabilization along West Kill Creek upstream of the Route 42 bridge in West Kill Hamlet. This will help protect the bridge from structural damage during future floods.

7. The Town of Lexington flood damage prevention code should be updated to meet the State of New York standards. In the State of New York, since 2007 the lowest floor including any basement must be at or above the base flood elevation *plus 2 feet*.

8. The town should identify parcels as part of a communitywide pollution protection program which could benefit from securing or relocating fuel tanks to eliminate a potential source of man-made pollution and apply for funding through the CWC.

9. The Town of Lexington should apply for a grant through the Catskill Watershed Corporation's Sustainable Communities Planning Program to identify areas within the municipality that may serve as new locations should any residences and/or businesses be purchased under the voluntary NYC Flood Buyout Program or the FEMA Hazard Mitigation Grant Assistance Program.

Table ES-1 presents a summary of all alternatives evaluated through the use of hydraulic modeling. Based on input received from the Lexington Flood Commission, a benefit-cost analysis was completed for a subset of the alternatives listed below as indicated.

TABLE ES-1
Lexington Flood Mitigation Alternatives

Alternative		Benefit-Cost Analysis Completed?	Cost Effective?
Study Area A – West Kill Hamlet			
A-3	Floodplain Enhancement downstream of Slater Road.	N	
A-1	Replace existing County Route 6 bridge over West Kill.	N	
A-2	Replace existing Route 42 bridge over West Kill.	N	
A-4	Reduce roughness from County Route 6 bridge to Route 42 bridge.	N	
A-5	Reduce roughness from Route 42 bridge to parcel 144.00-1-22.	N	
A-6	Sediment removal from County Route 6 bridge to Route 42 bridge	N	

	Alternative	Benefit-Cost Analysis Completed?	Cost Effective?
A-7	Sediment removal from Route 42 bridge to parcel 144.00-1-22	N	
Study Area B – Lexington Hamlet			
B-1	Replace existing Route 42 bridge over Schoharie Creek.	Y	N
B-2	Replace existing Route 42 bridge over West Kill ("Basil Bridge").	N	
B-2a	Supplement culvert under Route 42.	N	
B-2b	Construct levee at Basil property.	N	
B-3	Replace Van Valkenburgh Road bridge over West Kill. (Bridge was washed out in Irene.)	N	
B-4	Replace existing Route 42 bridge over West Kill near Beech Ridge Road.	N	
B-5a	Create floodplain along north side of Schoharie Creek. Grade up to the south edge of 13a.	Y	N
B-5b	Create floodplain along north side of Schoharie Creek. Grade up through 13a and establish new road or alternate access.	N	
B-1+B-5a	Combination of Alternatives B-1 and B-5a	Y	N
B-6a	Create wider, lower floodplain along south side of Schoharie Creek.	N	
B-6b	Create wider, lower floodplain along south side of Schoharie Creek downstream of the Route 42 bridge.	Y	N
B1+B-6b	Combination of Alternatives B-1 and B-6b	Y	N
B-7	Create wider, lower floodplain along south side of West Kill.	N	
B-8	Lower the floodplain along the south side of West Kill, staying mostly north of the road but including some land south of the road at the bridge alignment.	N	
B-9	Reduce roughness along Schoharie Creek where farmland was present long ago.	N	
B-10	Reduce roughness along the Schoharie Creek floodplain.	N	
B-11	Reduce roughness along West Kill between the two Route 42 bridges.	N	
B-12	Sediment removal from the main channel of Schoharie Creek upstream of West Kill	N	
B-13	Sediment removal from the main channel of West Kill	N	
B-14	Sediment removal from the main channel of Schoharie Creek downstream of West Kill	N	

Tables ES-2 (Lexington Hamlet) and ES-3 (West Kill Hamlet) list the potential funding sources for components of the recommended flood mitigation projects.

Table ES-2
Potential Funding Sources for Components of Mitigation Projects in Lexington Hamlet

Mitigation Projects		Federal	State	Other
Flood Mitigation in Center of Lexington Hamlet	Acquire home on south side of Route 13A.	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Acquire Lexington Hotel.	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Lower the sewer pipe between Route 13A and Schoharie Creek.	None	NYSDOS	CWC
	Create floodplain bench.	None	NYSDOS	GCSWCD SMP, CWC
	Replace Route 42 bridge.	None	NYSDOT	CWC
Flood Mitigation at Route 23A and Banks Road	Elevate homes.	FEMA	NYSDOS	CWC
	Conveyance and backwater reduction projects	None	NYSDOS	GCSWCD SMP, CWC
Building-Specific Mitigation Projects	Remove building in the Floodway: • Parcel 127.04-3-6 (Route 42, address unknown)	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Elevate buildings in FEMA SFHA: • 3589 Route 42 • 3609 Route 42 • 3617 Route 42 • Parcel 127.04-3-9 (east of town hall, address unknown)	FEMA	NYSDOS	CWC

Notes: FEMA = Federal Emergency Management Agency
NYSDOS = New York State Department of State
NYSDOT = New York State Department of Transportation
NYCDEP = New York City Department of Environmental Protection
CWC = Catskill Watershed Corporation
GCSWCD SMP = Greene County Soil & Water Conservation District Stream Management Program
SFHA = Special Flood Hazard Area

Table ES-3
Potential Funding Sources for Mitigation Projects in West Kill Hamlet

Mitigation Projects	Federal	State	Other
Remove buildings in the Floodway: • 2493 Route 42	FEMA	NYSDOS	CWC
Elevate buildings in FEMA SFHA: • 2486 Route 42* • 2516 Route 42	FEMA	NYSDOS	CWC
Elevate buildings in 500-year flood zone: • 173 Spruceton Road • 161 Spruceton Road • 141 Spruceton Road (Community Hall) • 2521 Route 42	FEMA	NYSDOS	CWC
Riverbank stabilization upstream of Route 42 bridge	FEMA, NRCS	NYSDOS	GCSWCD SMP, CWC

*This house is mapped in three risk zones (no risk, SFHA, and floodway) but is assumed to be primarily in the SFHA; the floodway boundary should be delineated more accurately.

Notes: FEMA = Federal Emergency Management Agency
SFHA = Special Flood Hazard Area
NRCS = Natural Resources Conservation Service
NYSDOS = New York State Department of State
CWC = Catskill Watershed Corporation
GCSWCD SMP = Greene County Soil & Water Conservation District Stream Management Program

Aside from the alternatives that were considered, there may be other key businesses, critical facilities, or residential buildings in the town of Lexington that can be relocated from zones of flood risk. This LFA supports the relocation of any critical facility that is currently at risk of flooding or will continue to be exposed to residual risk. If private property owners are interested in relocating elsewhere in the town, the buyout program could be used to facilitate relocations that are not part of the proposed alternatives. The Town Board may, at its discretion, seek to acquire the most flood-vulnerable properties where there is owner interest and programmatic funding available either through the Federal Emergency Management Agency (FEMA) or New York City Department of Environmental Protection (NYCDEP). Such properties would need to be approved by the Town Board for acquisition consideration.

As this LFA plan is implemented, the Lexington Flood Commission and the Town of Lexington will need to work closely with potential funders to ensure that the best combinations of funds are secured for the floodplain mitigation projects and for the property-specific mitigation such as floodproofing, elevations, and relocations.

1.0 INTRODUCTION

1.1 Project Background

The Greene County Soil & Water Conservation District (GCSWCD) retained Milone & MacBroom, Inc. (MMI) to complete a Local Flood Analysis (LFA) in the town of Lexington, New York, along Schoharie Creek and the West Kill in the hamlets of Lexington and West Kill. The LFA builds upon Federal Emergency Management Agency (FEMA) modeling to evaluate a variety of flooding issues in these communities and assess potential mitigation measures aimed at reducing flood inundation.

Flooding has been an ongoing concern in the town of Lexington culminating with Tropical Strom Irene, which struck the region on August 28, 2011. The storm resulted in extensive flooding and damage along both Schoharie Creek and the West Kill. Flows in Schoharie Creek in the hamlet of Lexington peaked at 40,500 cubic feet per second (cfs), which surpassed FEMA's projected 100-year storm event. On the West Kill, flows reached 19,100 cfs, which was close to the projected 500-year event.

Following Tropical Storm Irene, the New York City Department of Environmental Protection (NYCDEP) initiated the LFA program. The program's purpose is to assist communities within the New York City water supply watershed to identify long-term, cost-effective projects to mitigate flood hazards.

The intent of the LFA is to provide resources to help municipalities do the following:

- Confirm that there is a significant flood hazard in the target area through engineering analysis.
- Use engineering analysis to develop a range of hazard mitigation alternatives; the primary focus of the analysis is to identify the potential for reducing flood elevations through channel and floodplain restoration as the first alternative to other hazard mitigation solutions.
- Evaluate both the technical effectiveness and the benefit/cost effectiveness of each solution and compare different solutions to each other for the most practical, sustainable outcome (NYCDEP, 2014).

Project recommendations generated through an approved LFA may be eligible for flood hazard mitigation funding available through the Stream Management Implementation Program (administered by the County Soil and Water Conservation Districts), the Catskill Watershed Corporation's (CWC) Flood Hazard Mitigation Implementation Program, or the NYCDEP Voluntary Floodplain Buyout Program. Rules governing flood hazard mitigation project priorities and eligibility will be issued separately for each of these funding streams.

1.2 Study Areas

The project includes two study areas. Study Area "A" extends 2.1 miles along the West Kill through the hamlet of West Kill. The upstream study area boundary is located approximately 1,150 feet upstream of the County Route 6 bridge over the West Kill. The downstream boundary of Study Area A is located just outside of the hamlet of West Kill, 1.0 miles downstream of the Route 42 bridge. A map showing Study Area A and its stream stationing is shown in Figure 1-1.

Study Area "B" includes the confluence of Schoharie Creek and the West Kill, extending up both watercourses as well as downstream on Schoharie Creek. The upstream boundary of Study Area B on Schoharie Creek is 2.1 miles in length and reaches from the confluence to approximately 1,000 feet downstream of the Bush Road bridge. The upstream boundary of Study Area B on the West Kill is 1.4 miles in length and is located 400 feet upstream of the Route 42 bridge known as "Basil Bridge." The downstream boundary of Study Area B is located 0.7 miles downstream of the confluence of Schoharie Creek and the West Kill. A map showing Study Area B and its stream stationing is shown in Figure 1-2.

Both Study Area A and Study Area B are located within the town of Lexington, Greene County. Greene County is located in the northwest part of the Catskill Mountains of New York. The region was settled in the late 1700s, and the town of Lexington was formally established in 1813, originally as the town of New Goshen and then as Lexington. The 2010 census reports a population of 805 in the town of Lexington.

1.3 Nomenclature

In this report, all references to right bank and left bank assume that the reader is standing in the river looking downstream.

In order to provide a common standard, FEMA's National Flood Insurance Program (NFIP) has adopted a baseline probability called the base flood. The base flood has a 1 percent chance (one in 100) of occurring in any given year, and the base flood elevation (BFE) is the elevation of this level. For the purpose of this report, the 1 percent annual chance flood is referred to as the ***100-year flood event***. Other reoccurrence probabilities used in this report include the ***2-year flood event*** (50 percent annual chance flood), the ***10-year flood event*** (10 percent annual chance flood), the ***25-year flood event*** (4 percent annual chance flood), the ***50-year flood event*** (2 percent annual chance flood), and the ***500-year flood event*** (0.5 percent annual chance flood). The Special Flood Hazard Area (SFHA) is the area inundated by flooding during the 100-year flood event.

STUDY AREA A: WEST KILL

LEXINGTON LFHMA

HAMLET OF WEST KILL
LEXINGTON, NEW YORK

SOURCE(S):
Aerial: (c)2009 Microsoft Corporation

MILONE & MACBROOM
231 Main Street, Suite 102
New Paltz, New York 12561
(845) 633-8153
www.miloneandmacbroom.com

Map By: beckym
MMI#: 2884-03
MXD: Y:\2884-03\Maps\LFHMA\Figure1-1.mxd
1st Version: 8/7/2014
Revision:
Scale: 1 in = 600 ft

Figure 1-1

Figure 1-2

Map By: beckym
MMI#: 2884-03
MXD: Y:\2884-03\Maps\LFHMA\Figure1-2.mxd
1st Version: 8/7/2014
Revision:
Scale: 1 in = 958 ft

STUDY AREA B: WEST KILL AND SCHOHARIE CREEK

LEXINGTON LFHMA

HAMLET OF LEXINGTON
LEXINGTON, NEW YORK

SOURCE(S):
Aerial: (c)2009 Microsoft Corporation

MILONE & MACBROOM
231 Main Street, Suite 102
New Paltz, New York 12561
(845) 633-8153
www.miloneandmacbroom.com

1.4 Community Involvement

The first public meeting for the Town of Lexington LFA was held at 6:30 p.m. on the evening of March 3, 2014. The purpose of the meeting was to present an outline of the project, gather public input about flooding, and collect ideas for flood hazard mitigation options with emphasis on those that can be evaluated in the *Hydrologic Engineering Center River Analysis System* (HEC-RAS) using the FEMA hydraulic model.

On April 30, 2014, MMI presented preliminary HEC-RAS modeling results for each of the flood mitigation alternatives to the Lexington Flood Commission. A subset of flood mitigation alternatives was selected for more detailed analysis. Flood mitigation alternatives that resulted in negligible reductions in flooding or were not considered feasible were not evaluated further.

A conference call was held on June 13, 2014 with members of the Lexington Flood Commission. MMI presented information on water surface elevation reductions for each of the selected flood mitigation alternatives.

A meeting of the Lexington Flood Commission was held on July 1, 2014. MMI presented the results of a preliminary benefit-cost analysis for each of the selected flood mitigation alternatives.

On September 16, 2014, MMI met with the Lexington Flood Commission and the Town Board and presented an overview of LFA progress to date. MMI staff provided in-depth evaluation and benefit-cost analysis for the most feasible alternatives, presented additional options for buildings in the floodplain that will not benefit from structural alternatives, and explained next steps in the LFA process. The Lexington Flood Commission met on April 29, 2015 and December 15, 2015 to review final updates and seek recommendations regarding the study and report.

On November 1, 2014, a public meeting was held at the Methodist Church in Lexington Hamlet. At this meeting, MMI presented the final results of the Town of Lexington LFA.

2.0 EXISTING CONDITIONS

2.1 Initial Data Collection

Initial data collection included publicly available data as well as input from GCSWCD representatives. Appendix A includes a full listing of resource material gathered. A brief summary of key documents follows.

Flood Insurance Study (FIS)

FEMA published a Flood Insurance Study (FIS) effective May 16, 2008 for all of Greene County. The FIS includes Schoharie Creek and the West Kill. The purpose of the FIS was to determine potential floodwater elevations and delineate existing floodplains in order to identify flood hazards and establish insurance rates. The countywide study combines previous FISs of individual towns that were largely prepared during the 1980s, many of which had been prepared for FEMA by the U.S. Soil Conservation Service (now Natural Resources Conservation Service [NRCS]).

FEMA's revised hydraulic analysis and floodplain mapping effective in May 2008 were completed several years earlier in 2004 using aerial topographic maps produced from 2001 photographs. An important byproduct of the FIS is a series of HEC-RAS computer models that are available for professional use and are a key component of this study.

Stream Management Plans (SMP)

A detailed description of the Schoharie Creek watershed and channel is contained in the April 2007 Schoharie Creek Management Plan prepared by GCSWCD, with the assistance of NYCDEP. The report presents information on the watershed history, geography, flood history, floodplains, vegetation, land use, fisheries and wildlife, recreation, and water quality. The Management Plan also includes an inventory of 18 stream management units that assess site-specific conditions based upon field inspections and provide reach-by-reach recommendations. Management units 11 and 12 provide an assessment of stream conditions for the area of Schoharie Creek covered by this LFA. A digital copy of the plan can be found at:
http://www.catskillstreams.org/Schoharie_Creek_Management_Plan.html.

In the past, efforts to manage the stream were largely uncoordinated. Individual owners, municipalities, and utilities carried out their efforts in isolation. Federal agencies such as the NRCS and FEMA were concerned with addressing immediate problems and typically did not take a holistic view of the watershed. No single agency or entity was responsible for coordinating stream management efforts (GCSWCD 2007).

In order to meet water planning needs, a comprehensive watershed approach is required involving multiple stakeholders. The Schoharie Creek SMP is a tool to coordinate management activities in the watershed and has six primary goals (GCSWCD 2007):

- "Document risks and outline a plan to reduce damage to private property and public infrastructure - roads, bridges and utility lines – from floodwaters and stream erosion."

- "Summarize known information and outline a plan to protect and improve water quality, and identify any research gaps and recommend strategies to fill gaps."

- "Document current conditions and outline a plan to protect and enhance the integrity of stream and floodplain ecosystems, protect the unique communities of plants and animals that inhabit the stream and floodplains and encourage recreational opportunities."

- "Promote economic development through increased promotion of local streams, thus making the link between economic prosperity and stream health more apparent."

- "Develop an education and outreach strategy for the Schoharie watershed that promotes a stream stewardship ethic within the basin and raises awareness of the importance of water resources."

- "Provide a strategy for coordination of management activities among the various stakeholders, to ensure no one of the above goals is achieved at the expense of another."

The SMP provides recommendations for individual reaches in the Schoharie Creek stream system. In addition, it provides general recommendations for implementation at the community or watershed scale. These recommendations provide a framework to assist stakeholders in refining their efforts and address issues such as flood protection, public recreation, water quality, fishery habitat, riparian zone management, education and outreach, and programmatic approaches (GCSWCD 2007)

The West Kill SMP was written jointly by the GCSWCD and NYCDEP and completed in December 2005. The SMP includes an inventory of 21 stream management units. Management units 13 through 17 and management unit 21 cover the area of the West Kill included in this LFA. A digital copy is available at: http://www.catskillstreams.org/West_Kill_Stream_Management_Plan.html.

The West Kill SMP was created as a joint effort of local leaders, community members, and representatives of agencies involved with stream management. The plan identifies goals for watershed management and a set of general recommendations that closely match those of the Schoharie Creek SMP.

Hazard Mitigation Plans

The Federal Disaster Mitigation Act of 2000 (DMA 2000) was enacted to improve community responses to disasters by requiring state and local governments to develop Hazard Mitigation Plans (HMPs). The purpose of these plans is for communities to assess their vulnerability to natural disasters and to reduce or eliminate potential risk where possible. Additionally, the adoption of an HMP is required for communities to remain eligible for federal hazard mitigation assistance. Guidelines for HMPs are issued by FEMA, and responsibility for administering the plan has been delegated to the New York State Emergency Management Office (NYSEMO) (Tetra Tech 2009).

The NFIP is a federal hazard mitigation program with which the county is actively involved. This is a FEMA-administered program that assists the county in receiving funds for flood mitigation projects and flood insurance. The intent of the program is to insure that new construction within the SFHA is built to better withstand flooding and does not worsen flooding conditions (Tetra Tech 2009).

Another flood mitigation program administered by FEMA through the Flood Insurance Administration (FIA) is the Community Rating System (CRS). The goal of this program is to encourage local governments to improve their standards for floodplain development to increase floodplain protection and receive flood insurance discounts (Tetra Tech 2009).

Multijurisdictional Hazard Mitigation Plan

In 2009, Greene County adopted at multijurisdictional natural hazard mitigation plan. The plan includes an annex for the Town of Lexington. By participating in the plan, the town complies with DMA 2000 and is eligible to apply for federal aid for technical assistance and postdisaster mitigation project funding.

The report ranked flooding along with severe storms as having the highest probability of occurrence for the town of Lexington. Coupled with the fact that over 10 percent of the town's population of 830 (2000 Census) lives in the 100-year and 500-year floodplains, Lexington is particularly vulnerable to flood events. The computer model *HAZUS-MH MRH* estimates that for the 100-year flood event 90 people may be displaced, and 18 people may seek short-term sheltering, representing 10.8 percent and 2.2 percent of the town's population, respectively. A total of 74 properties were located within the 100- and 500-year flood boundaries. *HAZUS-MH MRH* estimated the replacement value of both structure and contents to be $16,779,000 (Tetra Tech 2009).

Water Quality Reports

Throughout the project area, Schoharie Creek is classified as a Class C (T) or C (TS) watercourse by the New York State Department of Environmental Conservation (NYSDEC). The West Kill is classified as Class C (TS) along its entire length. The "C" classification indicates a best usage for fishing. The additional designation of "T" or "TS" indicates that a water body has sufficient dissolved oxygen to support trout (T) or trout spawning (TS) (GCSWDC 2007). Neither Schoharie Creek nor the West Kill were listed on New York State's 2014 Section 303(d) inventory of impaired waters requiring a total maximum daily load (TMDL) or other strategy.

To fulfill requirements of the Federal Clean Water Act, the NYSDEC must provide periodic assessments of the quality of the water resources in the state and their ability to support specific uses. These assessments reflect monitoring and water quality information drawn from a number of programs and sources both within and outside the department. This information has been compiled by the NYSDEC Division of Water and merged into an inventory database of all water bodies in New York State. The database is used to record current water quality information, characterize known and/or suspected water quality problems and issues, and track progress toward their resolution.

The NYCDEP inventory of water quality information is the Waterbody Inventory/Priority Waterbodies List (WI/PWL). The most recent Mohawk River Basin Waterbody Inventory/Priority Waterbodies List Report was issued as a Final Draft Report in July 2010. The next review and update of the water quality assessments for waters in this basin were scheduled to be conducted in 2012 but do not appear on the NYSDEC web page.

The 2010 WI/PWL categorizes Schoharie Creek from the Schoharie Reservoir to the village of Hunter as having "minor impacts." The water quality impact is due to turbidity, which is caused by stream bank erosion along Schoharie Creek and its tributaries, particularly the East Kill, the West Kill, and Batavia Kill. In spite of turbidity, water quality sampling found that conditions are fully supportive of aquatic life and recreational use. The report also lists the West Kill as having "minor impacts." As with Schoharie Creek, the impact is due to turbidity caused by bank erosion.

Flood Damage Prevention Codes

The Town of Lexington has enacted a local code for flood damage prevention. The code is included in the Town of Lexington Zoning Law, which was adopted in November 2010. The stated purpose of the law is to prevent or minimize injury and death, the destruction or loss of private or public housing, and damage to public facilities.

The code includes the creation of a Floodplain Overlay District to minimize flood damage by controlling development in the 100-year floodplain. The boundaries of the district are based on the FEMA Flood Hazard maps for the Town of Lexington. The boundaries may be updated to reflect changes to the extent of the floodplain.

The Code Enforcement Officer is responsible for issuing building permits and ensuring that they do not conflict with zoning regulations. Additionally, the officer is authorized to make alterations to the Floodplain Overlay District where there appears to be a conflict between the FEMA flood map and actual site conditions.

According to the flood damage prevention codes, which are contained within the zoning law on the town's website, new residential construction and substantial improvements of any residential structure must have their lowest floor (including basement) elevated at or above the BFE. Nonresidential structures must also apply with this provision or may be floodproofed so that the structure is watertight below the BFE.

In the State of New York, since 2007, the lowest floor including any basement must be at or above the BFE *plus 2 feet*. The Town of Lexington flood damage prevention code should be updated to meet the State of New York standards.

2.2 Field Assessment

MMI staff conducted a visual inspection of the Schoharie Creek and West Kill channel and floodplain through the hamlets of Lexington and West Kill as well as a visual "windshield survey" of watershed and site conditions. These inspections included identification of low-lying structures, bank and channel conditions, and vegetation along the stream corridor. Channel reaches along both watercourses were photodocumented. A photo log is included as Appendix B.

2.3 Watershed Land Use

Figure 2-1 is a map of the Schoharie Creek and West Kill watersheds. The Schoharie Creek drainage basin drains an area of 135 square miles when measured at the downstream end of Study Area B. The creek originates east of the Hunter Mountain Ski Area and flows through the village of Hunter and the hamlet of Lexington. Schoharie Creek is joined by the West Kill at a point 9.3 miles upstream of Schoharie Reservoir, a potable drinking water source for New York City. The basin is approximately 94 percent forested (*StreamStats*, 2014) with a mix of residential and commercial land uses concentrated in the village of Hunter and the hamlet of Lexington. Rural residential and agricultural uses are located along the river corridor, which parallels Route 23A for much of its length. A portion of the watershed is located within the protected 700,000-acre Catskill State Park.

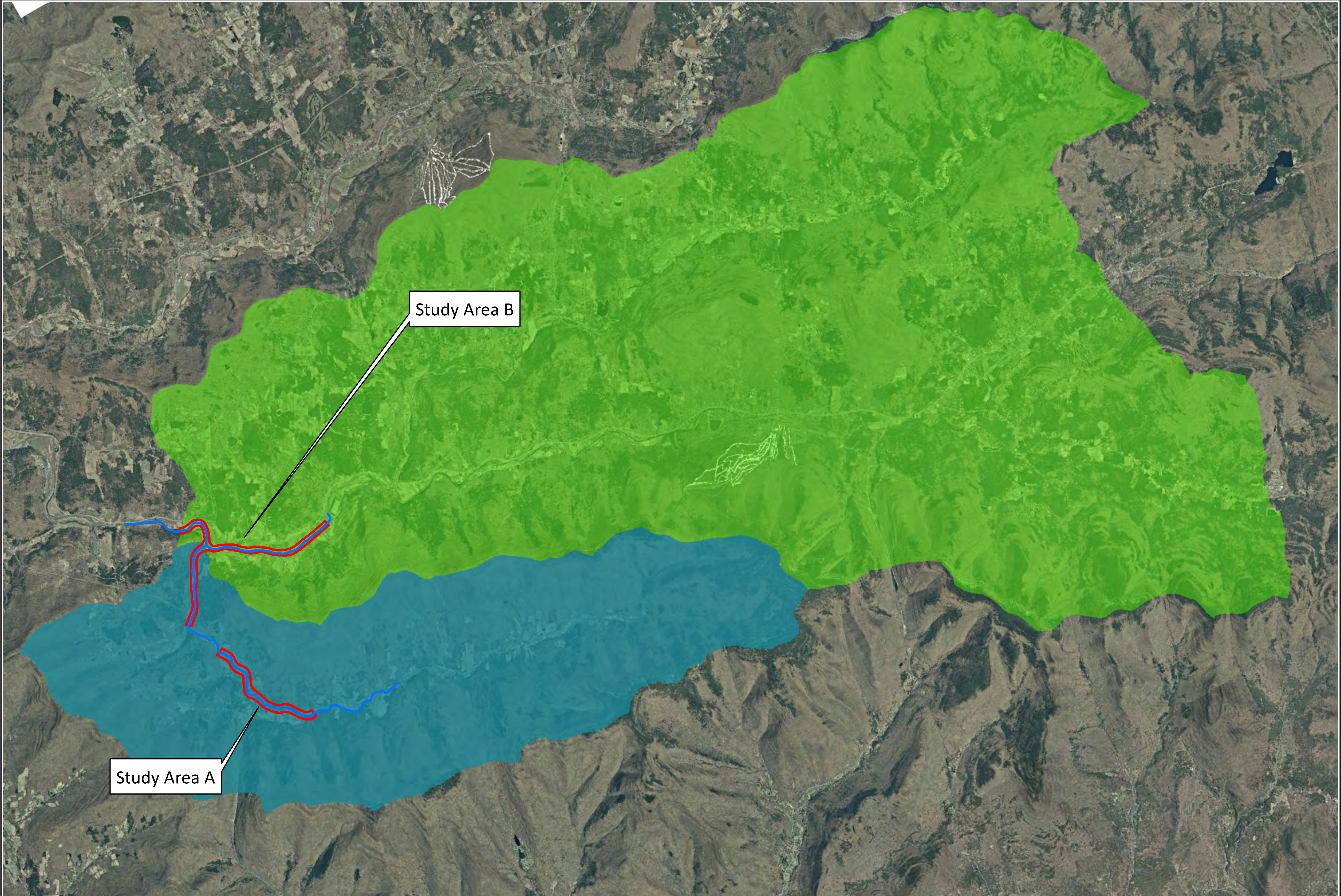
The West Kill drains an area of 31.3 square miles, originating on Hunter Mountain and flowing through the hamlets of Spruceton and West Kill before emptying into Schoharie Creek in the hamlet of Lexington. The West Kill parallels County Route 6 (Spruceton Road) and then Route 42. The headwaters of the West Kill are located in the town of Hunter while most of the watershed is located in the town of Lexington, in Greene County, New York. The basin is approximately 96 percent forested (*StreamStats*, 2014) with a mix of residential and commercial land uses concentrated in the hamlets, sparse rural residential uses outside of the hamlets, as well as agricultural uses located primarily along the river corridor.

2.4 Watershed and Stream Characteristics

The 135-square-mile drainage basin of Schoharie Creek has an east-to-west orientation and is characterized by steep, mountainous slopes, especially near its headwaters where the watershed divide follows the summits of Roundtop Mountain and High Peak, which exceed 3,500 feet in elevation. Tributaries to Schoharie Creek include the East Kill and the West Kill.

The watershed is underlain by unsorted glacial till as well as gravel deposits and areas of lacustrine clays along the valley floor. When exposed by the erosive action of the river, these lacustrine clays are mobilized, resulting in high turbidity and contributing to water quality issues. The underlying bedrock consists of shale, sandstones, and siltstones as well as conglomerates that tend to form the mountain tops (Schoharie Creek Management Plan, 2007).

Schoharie Creek flows generally northwest from its headwaters to Schoharie Reservoir, with a consistent channel slope of approximately 0.6 percent over this length. Schoharie Creek flows through a partially confined valley setting, with the channel confined on one or both sides by steep valley walls and discontinuous areas of floodplain occurring where the valley walls widen. Channel bed sediments range in size from sand to boulders. The river flows across exposed bedrock at several locations along its length.



STUDY AREA A AND B WATERSHED MAP

LEXINGTON LFHMA

HAMLET OF WEST KILL
LEXINGTON, NEW YORK

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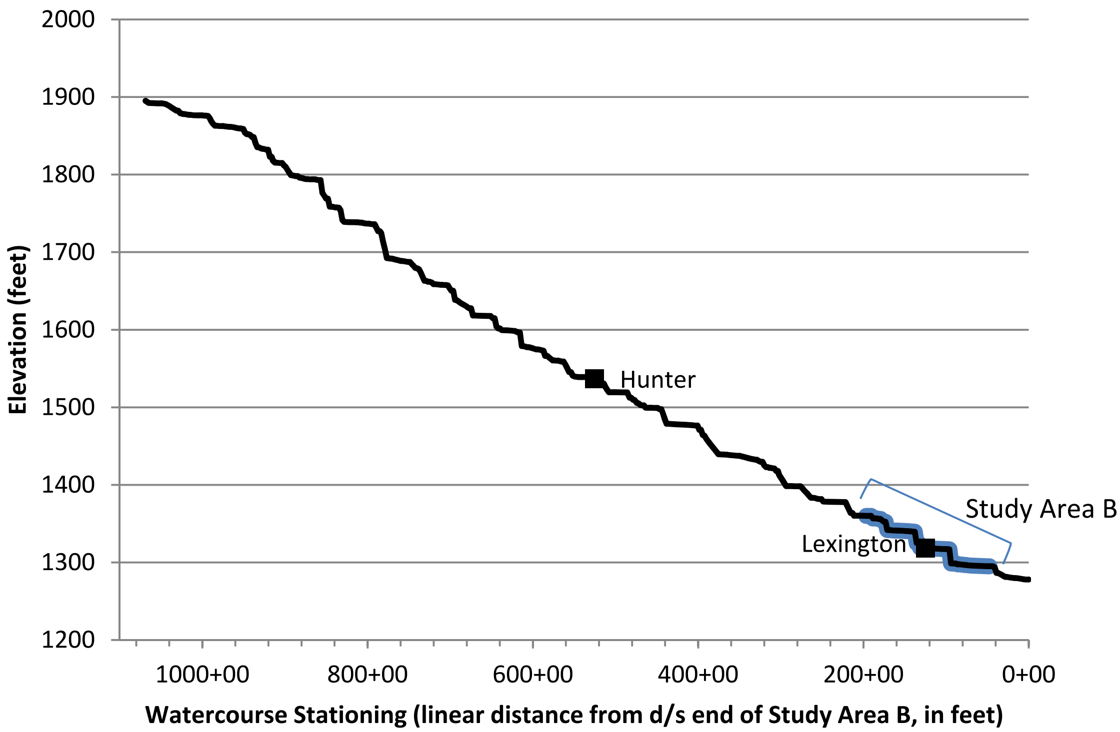
Figure 2-1

Figure 2-2 is a profile of Schoharie Creek showing its elevation versus linear distance upstream from Study Area B as well as the locations of the village of Hunter and the hamlet of Lexington. The watercourse drops a total of 617 vertical feet over this length.

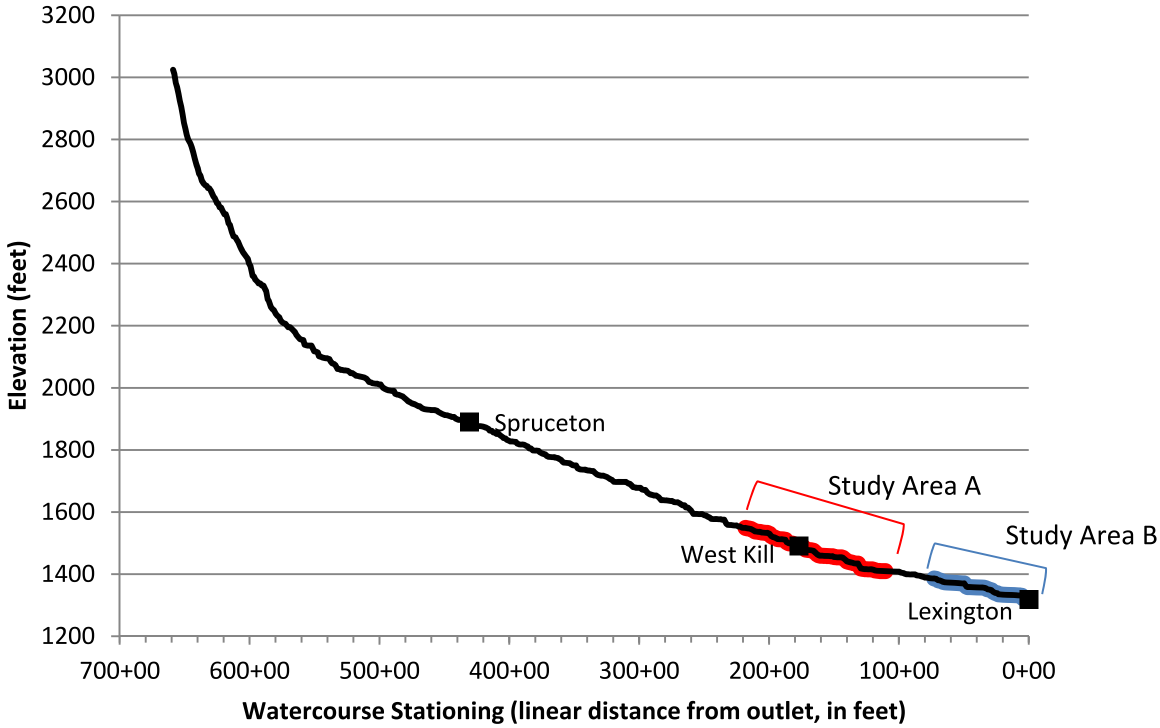
Figure 2-2
Schoharie Creek Channel Profile



The West Kill flows generally west from its headwaters to the hamlet of West Kill, then north to join Schoharie Creek. The West Kill is much steeper than Schoharie Creek with an overall slope of 2.6 percent. The upper portion of the West Kill, upstream of the eastern terminus of County Route 6 (Spruceton Road), has a very steep overall slope exceeding 7.0 percent. The West Kill flows through a confined valley setting with the channel narrowly confined on both sides by the steep, mountainous valley walls. The West Kill channel from the terminus of County Route 6 downstream to the outlet at Schoharie Creek has a more moderate slope of 1.5 percent and flows through a partially confined valley setting with narrow, discontinuous areas of floodplain occurring in areas where the valley walls widen.

Figure 2-3 is a profile of the West Kill showing its elevation versus linear distance upstream from its confluence with Schoharie Creek as well as the locations of Study Area A, Study Area B, and hamlets along the stream. The watercourse drops a total of 1,706 vertical feet over its entire length.

Figure 2-3
West Kill Channel Profile



2.5 Infrastructure

Five bridges cross Schoharie Creek and the West Kill within the study areas. Table 2-1 lists the bridge crossings within Study Areas A and B, the stream station location of each, the predicted water surface elevation during the 100-year flood event, and bridge deck elevation.

TABLE 2-1
Bridge Crossings

Bridge Crossing	Predicted 100-Year WSEL	Bridge Deck Elevation
Study Area A		
County Route 6 over West Kill	1526.1	1527.5
Route 42 over West Kill (upper)	1461.3	1464.0
Study Area B		
Route 42 over West Kill (lower)	1382.3	1386.4
Route 42 over West Kill (Basil Bridge)	1334.3	1335.9
Route 42 over Schoharie Creek	1332.3	1330.8

Water surface elevation profiles generated by the hydraulic modeling indicate that flows in Schoharie Creek come close to overtopping the Route 42 bridge during the 100-year flood event and do overtop the bridge during the 500-year event. The bridge acts as a hydraulic constriction during the 50-, 100-, and 500-year flood events with floodwaters "piling up" upstream of the bridge.

On the West Kill, floodwaters hit the low beam of the County Route 6 bridge and the upper Route 42 bridge during the 50-, 100-, and 500-year flood events. During the 100-year flood event, flows bypass these bridges at low-lying areas on either side but do not overtop the deck. The lower Route 42 bridge is overtopped during the 500-year flood event while smaller-magnitude events bypass the bridge. Further downstream, the Route 42 "Basil Bridge" does not act as a hydraulic constriction and does not overtop although floodwaters do hit the low beam during the 500-year flood event.

The FEMA model indicates two bridges crossing the West Kill that are no longer in place. The Van Valkenburgh Road bridge, which was located approximately 500 feet upstream of Schoharie Creek, and a private road crossing located approximately 1.75 miles upstream of Schoharie Creek. Both of these bridges were washed out during Tropical Storm Irene. The private road crossing has been replaced.

2.6 Hydrology

Surface water hydrologic studies are conducted to understand historical and potential future river flow rates. Predictions of potential flow rates are made using data from stream gauging stations as well as predictive models. These predictions of flow rates allow communities to plan for future events and reduce the risk of flooding.

USGS Stream Gauging Network

The United States Geological Survey (USGS) operates and maintains two stream flow gauges in the project area. USGS Gauge 1349810 is located on the West Kill about 1.7 miles downstream of the hamlet of West Kill. The second gauge (1349705) is located on Schoharie Creek approximately 1.4 miles upstream of the Route 42 bridge in Lexington, New York. The gauges record daily stream flow including flood flows that are essential to understanding long-term runoff trends. Gauge data can be utilized to determine flood magnitudes and frequencies. Additionally, real time data is available to monitor water levels and provide flood alerts. Stream flow data and water levels are available at http://waterdata.usgs.gov/ny/nwis/sw. Table 2-2 is a list of active USGS water surface stream gauging stations along Schoharie Creek and the West Kill.

TABLE 2-2
USGS Gauging Stations

USGS Gauge Number	Location	Drainage Area (square miles)	Period of Record
01349705	Schoharie Creek near Lexington	96.8	August 1999 to present
01349810	West Kill near West Kill	27.0	January 1996 to present

The most current FEMA FIS that covers all jurisdictions in Greene County including the study areas has an effective date of May 16, 2008. The purpose of the FEMA study is to determine potential floodwater elevations and delineate existing floodplains in order to identify flood hazards and establish insurance rates. The hydrologic analysis methods employed in the FEMA study followed the standardized regional regression equation procedure detailed by the USGS publication 90-4197, *Regionalization of Flood Discharges for Rural, Unregulated Streams in New York, Excluding Long Island*. This procedure relates runoff discharge to the mean annual precipitation and several other parameters based on watershed basin characteristics within a number of geographically distinct regions in New York State. The Greene County watersheds fall within USGS Region 4 for New York State. The parameters required for the Region 4 regression equations included mean annual precipitation, watershed area, and basin storage. Basin storage is defined by USGS as the percentage of the area within a watershed covered by lakes, ponds, or swamps (FEMA, 2008).

Hydrologic data on peak flood flow rates along Schoharie Creek and the West Kill are available from the FEMA FIS and from the USGS *StreamStats* program. Table 2-3 lists peak discharges for the 10-, 50-, 100-, and 500-year flood events at points along Schoharie Creek and the West Kill within the study area as determined by FEMA and reported in the FIS (FEMA, 2008).

TABLE 2-3
FEMA Peak Discharges

Location	Drainage Area (sq. mi.)	10-year flood event	50-year flood event	100-year flood event	500-year flood event
Schoharie Creek					
At State Route 42 bridge	99.6	17,190	31,130	37,810	56,060
West Kill					
Confluence with Schoharie Creek	31.4	5,520	10,230	12,700	19,630
At State Route 42 (upper)	22.4	4,290	8,080	10,080	15,770

Peak discharges for the 2- and 25-year flood events, which are not reported by FEMA, were determined using the *StreamStats* program and are reported in Table 2-4. Peak discharges for the 10-, 50-, 100-, and 500-year flood events were also determined using the *StreamStats* program and compared to those reported by FEMA. Discharges reported by FEMA are higher than those determined using *StreamStats*. The FEMA discharges were used in this analysis for the 10-, 50-, 100-, and 500-year flood events because they are (a) more conservative; and (b) the jurisdictional standard.

TABLE 2-4
***StreamStats* Peak Discharges**

Location	Drainage Area (sq. mi.)	2-year flood event	25-year flood event
Schoharie Creek			
At State Route 42 bridge	99.5	6,460	19,000
West Kill			
Confluence with Schoharie Creek	31.3	2,430	7,440
At State Route 42 (upper)	22.7	1,850	7,160

Bankfull discharge is defined as that flow which fills the channel to the top of the bank to the level where the water is just about to spill into the floodplain. It is considered important because it transports the greatest amount of sediment over time due to the frequency of occurrence. As a result, bankfull discharges are critical to channel maintenance and play a key role in determining the morphological characteristics of the channel. Based upon flood frequency analysis, bankfull discharge occurs approximately every 1.5 years on average (Rosgen 1996).

Extensive data sets indicate the channel forming or bankfull discharge in specific regions is primarily a function of watershed area and soil conditions. Bankfull dimensions including discharge, area, width, and depth represent long-term equilibrium conditions in alluvial channels and are important geophysical criteria that are used for design. Table 2-5 lists estimated bankfull discharge, width, and depth at several points within the study area. As bankfull flow and dimensions are not calculated by FEMA, these measurements were derived from the USGS *StreamStats* program.

TABLE 2-5
Estimated Bankfull Discharge, Width, and Depth
(Source: USGS *StreamStats*)

Location	Drainage Area (sq. mi.)	Bankfull Flow (cfs)	Bankfull Area (sq ft)	Bankfull Depth (ft)	Bankfull Width (ft)
Schoharie Creek					
At State Route 42 bridge	99.5	4,240	639	4.54	142
West Kill					
Confluence with Schoharie Creek	31.3	1,720	260	3.15	83.4
At State Route 42 (upper)	22.7	1,340	203	2.85	71.9

3.0 FLOODING HAZARDS AND MITIGATION ALTERNATIVES

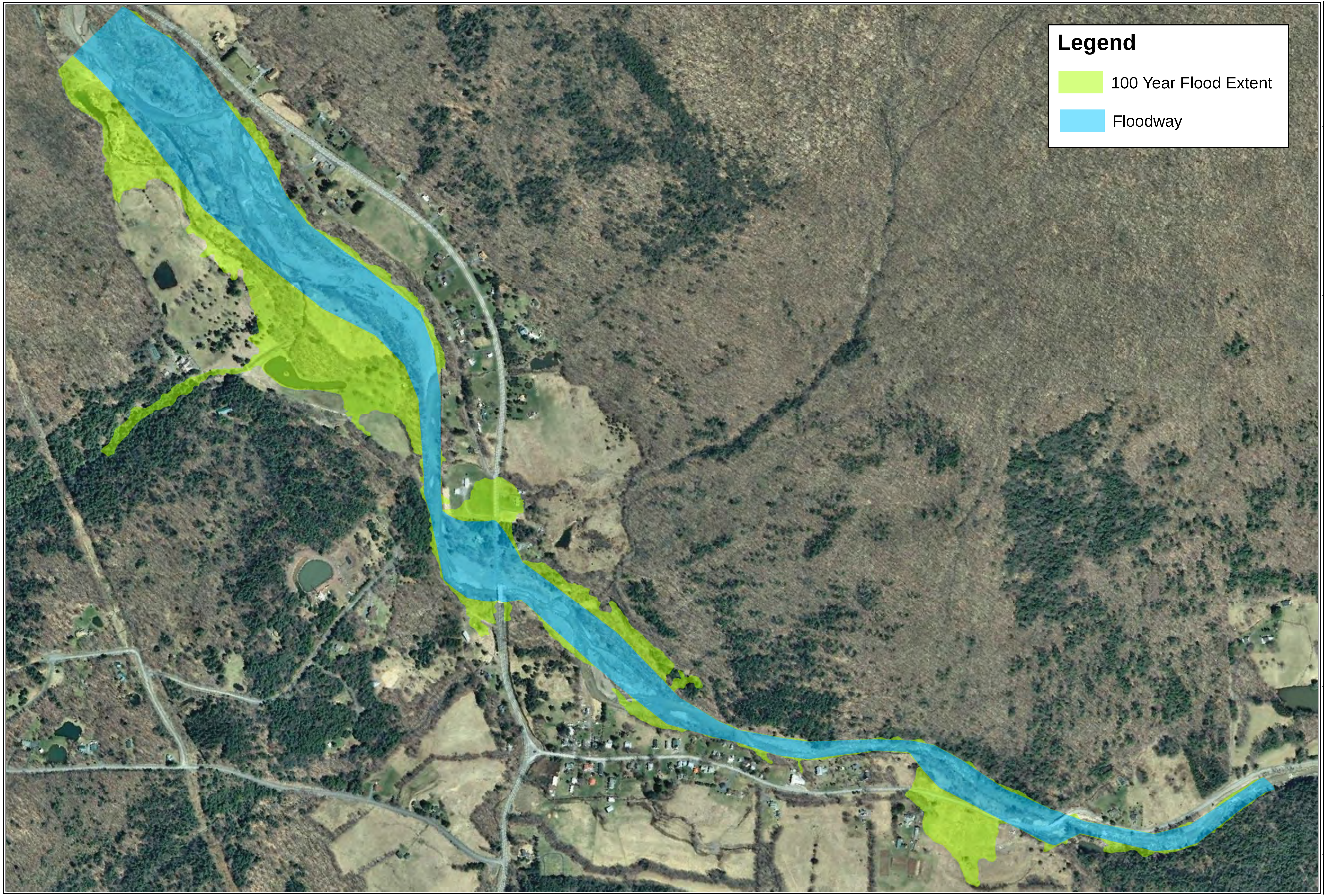
3.1 Flooding History Along Schoharie Creek and the West Kill

The Schoharie Creek watershed averages approximately 46 inches of precipitation per year in the upper reaches near Hunter, 42 inches per year in the mid sections in Lexington, and 38.5 inches per year near Prattsville and the Schoharie Reservoir (GCSWCD, 2007). According to the FEMA FIS, flooding can occur in any month of the year in Greene County. The majority of the larger floods have occurred in either late winter or early spring when snowmelt adds to heavy spring rains to produce increased runoff. Summer and fall floods also occur due to hurricane activity (FEMA, 2008). Major floods occurred in Greene County in 1955, 1987, 1996, 1999, 2000, 2003, 2005, 2006, and 2007 (Tetra-Tech, 2009).

3.2 FEMA Mapping

FEMA Flood Insurance Rate Maps (FIRMs) are available for the study areas and depict the SFHA, which is the area inundated by flooding during the 100-year flood event. FEMA FIRMs for the project areas are depicted in Figures 3-1 and 3-2 for project areas A and B, respectively.

The maps also depict the FEMA designated floodway, which is the stream channel and that portion of the adjacent floodplain that must remain open to permit passage of the base flood. Floodwaters are typically deepest and swiftest in the floodway, and anything in this area is in the greatest danger during a flood (FEMA, 2008).



STUDY AREA A: WEST KILL

LEXINGTON LFHMA

HAMLET OF WEST KILL
LEXINGTON, NEW YORK

SOURCE(S):
Aerial: (c)2009 Microsoft Corporation

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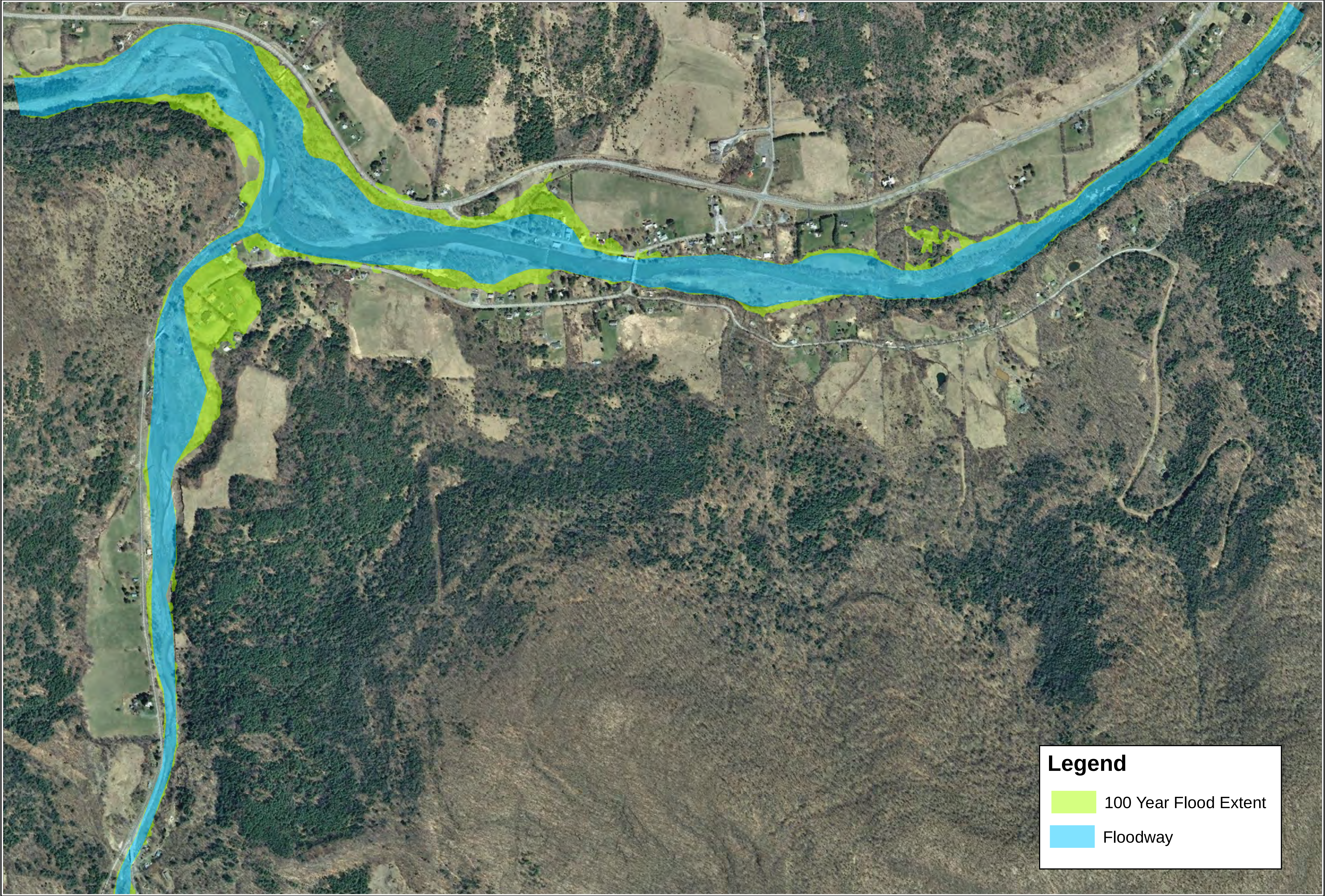
Figure 3-1



STUDY AREA B: WEST KILL AND SCHOHARIE CREEK

LEXINGTON LFHMA

HAMLET OF LEXINGTON
LEXINGTON, NEW YORK

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Figure 3-2

3.3 Tropical Storm Irene

In August 2011, Tropical Storm Irene caused extensive flooding and devastation in eastern New York, including along Schoharie Creek and the West Kill. Flows during Irene peaked on Schoharie Creek near Lexington at 40,500 cfs, surpassing FEMA's predicted 100-year flood event of 36,810 cfs. On the West Kill, flows peaked at 19,100 cfs, far surpassing the FEMA 100-year flow of 12,700 cfs and coming close to the 500-year flow of 19,630 cfs. Figures 3-3 and 3-4 illustrate the peak flows experienced during Tropical Storm Irene on Schoharie Creek and the West Kill, respectively.

Figure 3-3
Peak Flow on Schoharie Creek During Tropical Storm Irene

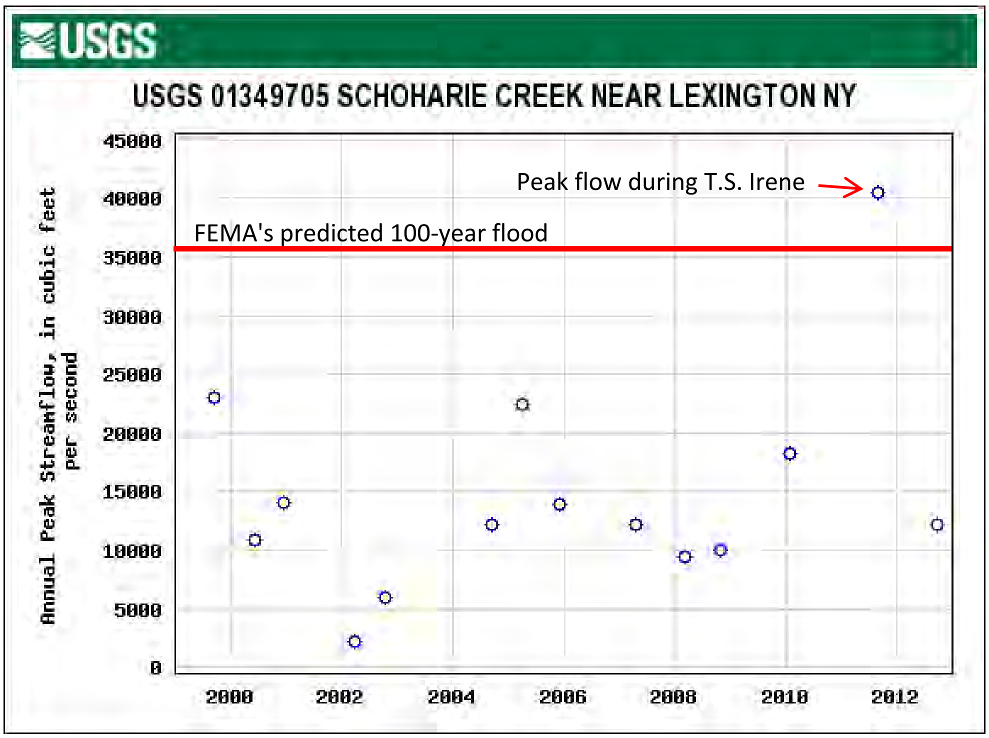
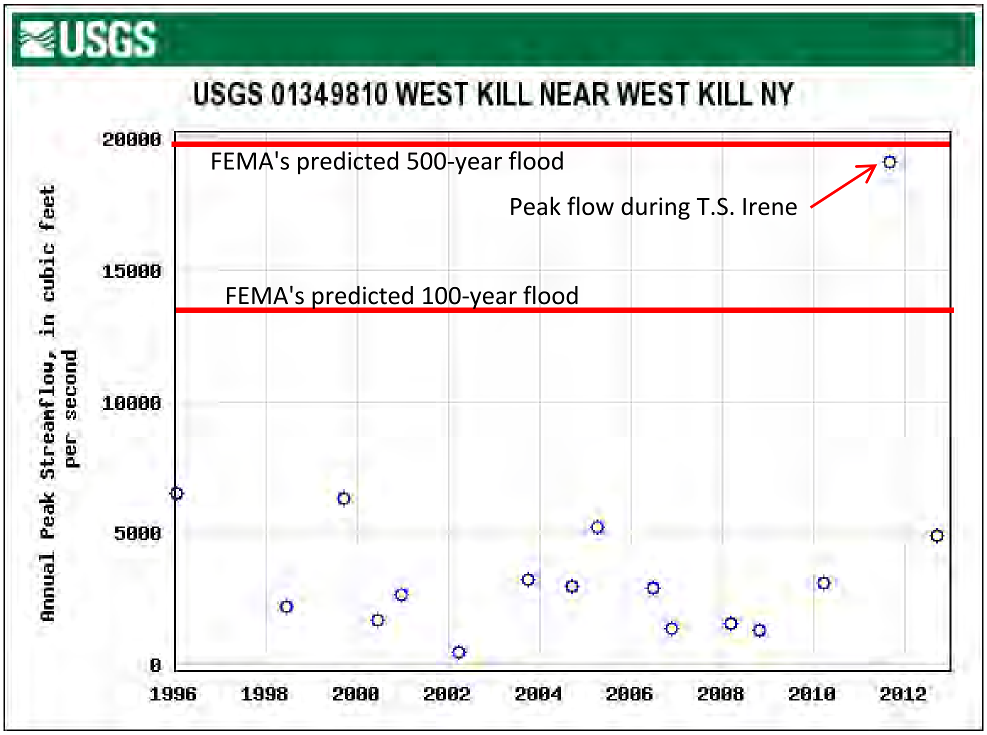


Figure 3-4
Peak Flow on the West Kill During Tropical Storm Irene



Photographs and news accounts from Tropical Storm Irene paint a vivid picture of the extensive damage that occurred throughout the study area. Extensive bank erosion and flood-related damage to buildings and properties occurred in the hamlet of Lexington along Route 13a and Route 42. Flood flows from Schoharie Creek overtopped the Route 42 bridge. Damage occurred to homes, roads, and bridges along the West Kill.

4.0 FLOOD MITIGATION ANALYSIS AND ALTERNATIVES

4.1 Analysis Approach

MMI obtained the effective FEMA HEC-RAS model from the GCSWCD. Hydraulic analysis of Schoharie Creek and the West Kill through Study Area A and Study Area B was conducted using the HEC-RAS program. The HEC-RAS software version 4.1.0 (*River Analysis System*) was written by the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC) and is considered to be the industry standard for riverine flood analysis. The model is used to compute water surface profiles for one-dimensional, steady-state, or time-varied flow. The system can accommodate a full network of channels, a dendritic system, or a single river reach. HEC-RAS is capable of modeling water surface profiles under subcritical, supercritical, and mixed-flow conditions.

Water surface profiles are computed from one cross section to the next by solving the one-dimensional energy equation with an iterative procedure called the standard step method. Energy losses are evaluated by friction (Manning's Equation) and the contraction/expansion of flow through the channel. The momentum equation is used in situations where the water surface profile is rapidly varied, such as hydraulic jumps, mixed-flow regime calculations, hydraulics of dams and bridges, and evaluating profiles at a river confluence.

Hydraulic modeling conducted by FEMA was used as a starting point for the current analysis. FEMA modeled Schoharie Creek and the West Kill separately and did not model the confluence of the two rivers. The Schoharie Creek model extends from 200 feet upstream of Elka Park Road in Elka Park, New York to the Schoharie Reservoir and is comprised of a total of 950 cross sections. The West Kill model extends from 700 feet upstream of Advan Road in Hunter, New York to its confluence with Schoharie Creek and is comprised of a total of 255 cross sections.

The HEC-RAS models were run, and the resulting water surface elevations were compared to those published in the FEMA FIS and verified for accuracy. The FEMA model is large and complex. To evaluate Study Areas A and B, MMI made the following revisions that were deemed appropriate for the subject study:

- The models were truncated to conform with the study reaches, extending from FEMA section "L" to FEMA section "Q" for Schoharie Creek and from FEMA section "A" to FEMA section "I" for West Kill. The Schoharie Creek model created for the study area is comprised of 182 cross sections. The West Kill model created for the study area is comprised of 129 cross sections.

- Key nodes were labeled so the profile is easier to read.

The revised models were run and tested to validate the above changes.

Replacement of bridges and substantial modifications to the channel may have occurred since the survey for the FEMA model was completed as a result of recent flood events. While the model is sufficiently accurate for evaluation of flood mitigation alternatives and development of design concepts in the study area, more detailed, up-to-date survey will be required for regulatory permitting and final design.

MMI utilized the truncated FEMA models for Schoharie Creek and West Kill as the Existing Conditions model against which alternatives were compared.

4.2 Mitigation Approaches

A number of flood mitigation approaches were evaluated within the study area.

Bridge Removal/Replacement

Undersized bridges can act as hydraulic constrictions, exacerbating flooding during high-flow events by increasing water surface elevations upstream of the bridge. Each bridge within the study area was evaluated. If the bridge appeared to be acting as a hydraulic constriction, it was removed from the model, which simulates the complete removal of the bridge from the channel. If bridge removal resulted in a significant reduction in water surface elevations and a resulting reduction of the flooding of structures and/or roads in the model, bridge replacement with a more hydraulically adequate structure was advanced for consideration.

Sediment Removal or "Dredging"

During the public meeting, residents expressed a sentiment that dredging would alleviate flooding and should be pursued. The need for dredging can be reduced by decreasing the sediment load at its source and improving sediment transport through reaches that are vulnerable to deposition. Sediments are likely to continue to be transported downstream to some extent regardless of what actions are taken to control the source in the upper reaches.

Dredging is often the first response to flooding. However, overwidening or overdeepening through dredging can initiate instability (including bed and bank erosion) and foster poor sediment transport while not necessarily providing significant flood mitigation. Sediment removal can further isolate a stream from its natural floodplain, disrupt sediment transport, expose erodible sediments, cause upstream bank/channel scour, and encourage additional downstream sediment deposition. Improperly dredged stream channels often show signs of severe instability, which can cause larger problems after the work is complete. Such a condition is likely to exacerbate flooding on a long-term basis.

Floodplain Creation/Enhancement (Natural Channel Design and Floodplain Enhancement)

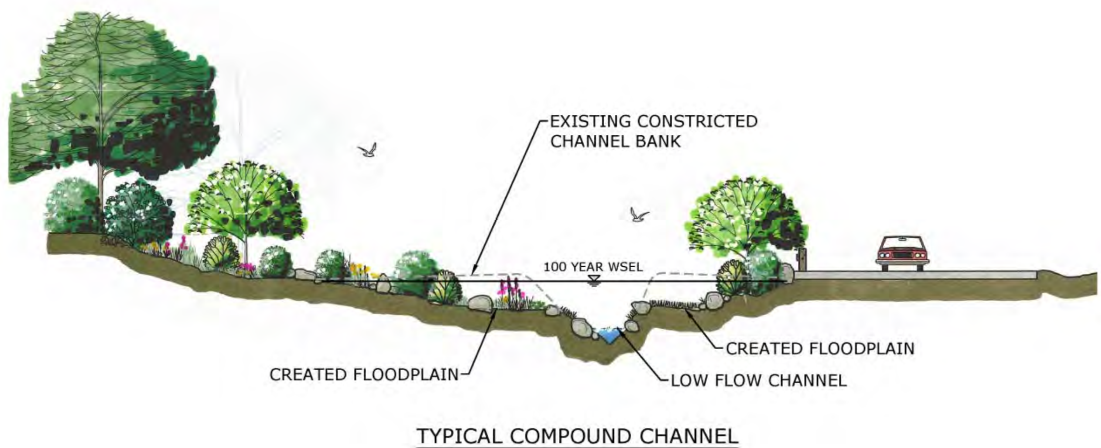
Historical settlement patterns and human desire to build near water has led to centuries of development clustered along the banks of rivers all over the nation. The hamlets of Lexington and West Kill are a good example of development along a river corridor. Unfortunately, dense development and placement of fill in the natural floodplain can severely hinder a river's ability to convey flood flows without overtopping its banks and/or causing heavy flood damage.

A river in flood stage must convey large amounts of water through a finite floodplain. When a channel is constricted or confined, velocities can become destructively high during a flood, with dramatic erosion and damage. When obstructions are placed in the floodplain, whether they are in the form of structures, infrastructure, or fill, they are vulnerable to flooding and damage.

Natural channels are typically comprised of a compound channel whereby normal flow is conveyed in a low-flow channel that is flanked by an active floodplain, which is ideally a vegetated, undeveloped corridor at a slightly higher elevation that is able to convey high flows. Although rivers in their natural setting seem to be at their low-flow stage most often, the entire flood-prone corridor is part of the river, and the importance of the floodplain only becomes evident on rare but extreme occasions.

In certain instances, an existing floodplain can be altered through reclamation, creation, or enhancement to increase flood conveyance capacity. Floodplain *reclamation* can be accomplished by excavating previously filled areas, removing berms or obstructions from the floodplain, or removal of structures. Floodplain *creation* can be accomplished by excavating land to create new floodplain where there is none today. Finally, floodplain *enhancement* can be accomplished by excavating within the existing floodplain adjacent to the river to increase flood flow conveyance. These excavated areas are sometimes referred to as floodplain benches. The graphic below shows a typical cross section of compound channel with excavated floodplain benches on both banks. The graphic shows flood benches on both banks; however, flood benches can occur on either or both banks of a river.

Typical Cross Section of a Compound Channel



Combinations of Approaches

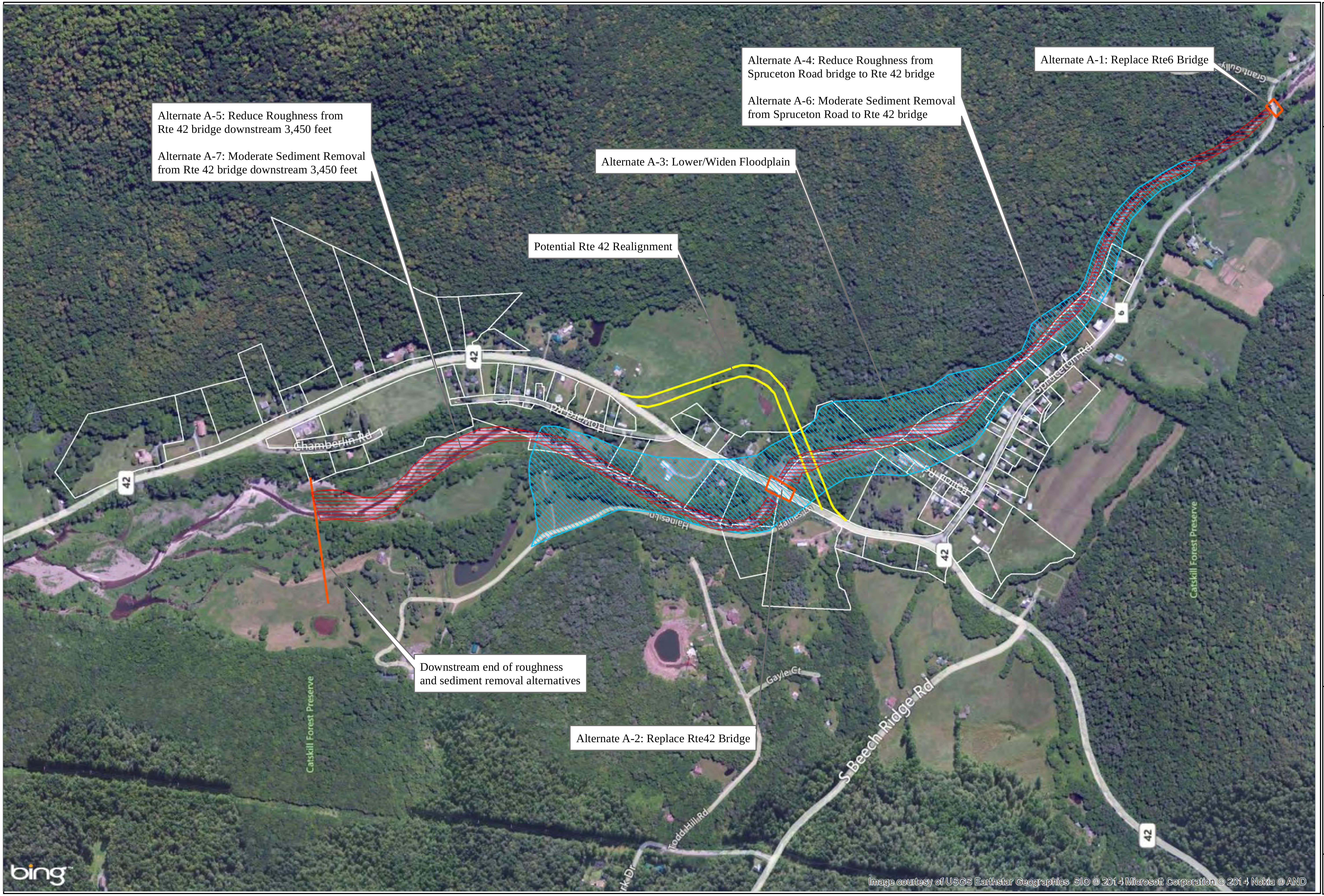
Combinations of the above approaches, such as bridge modification combined with floodplain creation/enhancement, were also modeled.

4.3 Analysis of Flood Mitigation Alternatives

A total of 21 individual flood mitigation alternatives were initially tested: seven in Study Area A and 14 in Study Area B. These initial tested alternatives were assessed using HEC-RAS hydraulic modeling, and the results were discussed through a series of conference calls and meetings with the Lexington Flood Commission. A determination was then made as to whether the flood mitigation benefits of each alternative warranted further evaluation.

The seven flood mitigation alternatives initially assessed for Study Area A are summarized in Table 4-1 and depicted graphically in Figure 4-1. The 14 flood mitigation alternatives initially assessed for Study Area B are summarized in Table 4-2 and depicted graphically in Figure 4-2. Each alternative is designated with either an "A" or "B" as the prefix to indicate its location within either study area.

The State Route 42 bridge over West Kill was evaluated as Alternative B-2. The NYSDOT plans to replace this bridge, and MMI recommends that the replacement bridge be adequately sized for anticipated flows. The current bridge has a span of 120 feet and is skewed 45 degrees to the flow direction of West Kill. Widening the bridge has no effect on water surface elevations, indicating that the bridge low chord must be elevated to avoid pressure flow and overtopping. The bridge slopes from left to right, with the lowest chord at elevation 1,331.71 feet in North American Vertical Datum of 1998 (NAVD88). Water surface elevations upstream of the bridge for the 100-year storm are 1,333.18 feet NAVD88. Although the left side of the bridge allows unimpeded flow, the right abutment and low chord act as constrictions to flow. The replacement bridge should provide a minimum foot of freeboard for the 100-year storm, which would require a higher abutment on the right bank and street grading to achieve the necessary clearance. The proximity of residences and driveways along with the narrow channel may prevent the construction of a bridge with a wider span.



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ALTERNATIVES: STUDY AREA A

LEXINGTON LFHMA

HAMLET OF WEST KILL
LEXINGTON, NEW YORK

Map By: BeckyM
MMI#: 2884-03
MXD: Y:\2884-03\Maps
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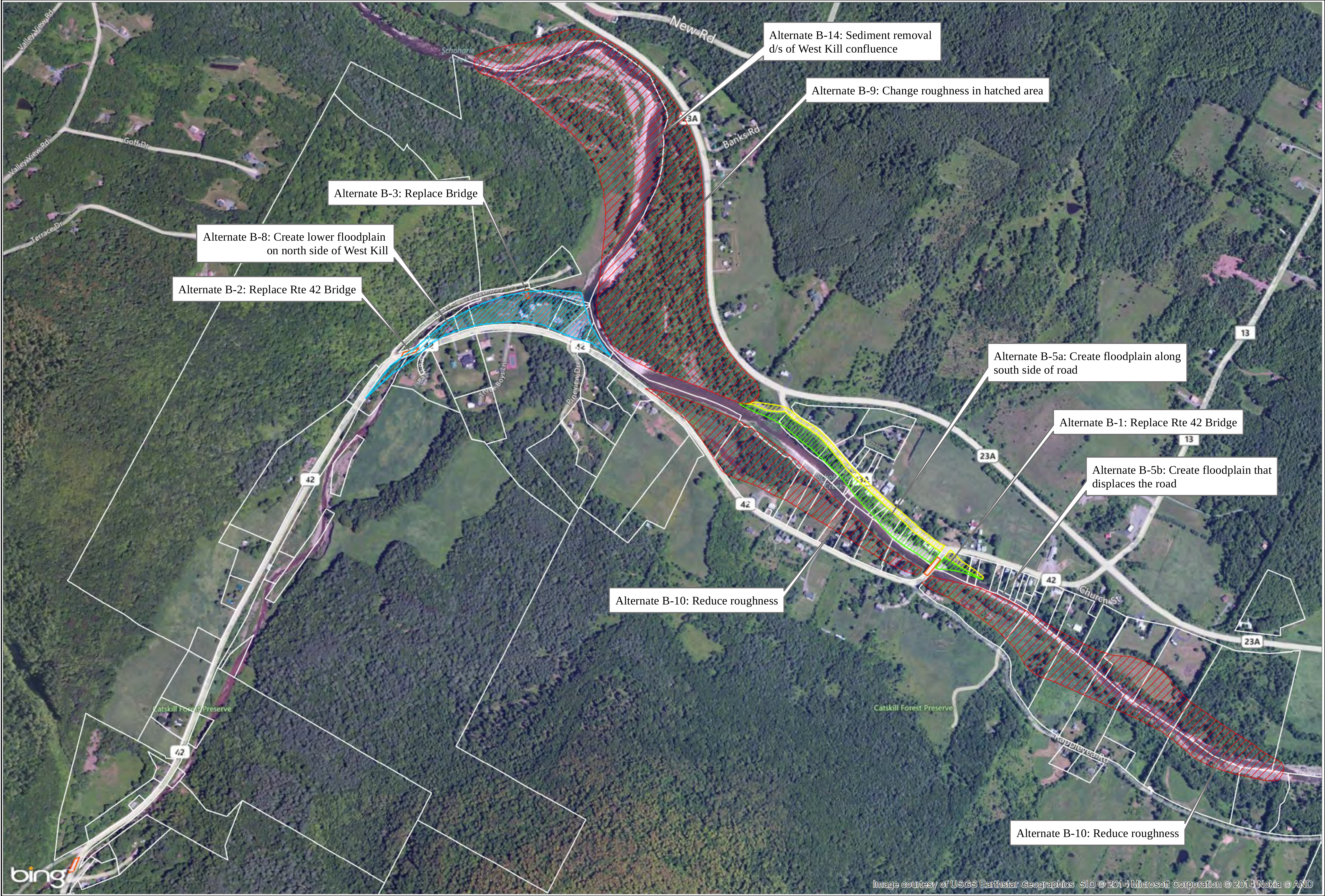
Revision:
Scale: 1 in = 567 ft

Figure 4-1

TABLE 4-1
Flood Mitigation Alternatives
Study Area A – West Kill Hamlet

Alternative	Notes	Recommended for Further Evaluation?
A-3: Lower and widen floodplain; realign Route 42.	Evaluating this alternative included excavating a large portion of floodplain along the West Kill's left bank. The widening has a negligible effect on the predicted 100-year water surface elevations through the modified reach despite the significant floodplain excavation. There is very little effect on lateral extents of flooding.	**N**
A-1: Replace existing County Route 6 bridge over West Kill.	A review of the water surface profile at the bridge section indicates that a larger bridge would have little impact on water surface elevations at the bridge crossing. No structures benefit from very local reduction in water surface elevation.	**N**
A-2: Replace existing Route 42 bridge over West Kill.	This alternative would require that some homes be removed. The Route 42 crossing would be realigned to cross the floodplain at a right angle to eliminate the reduction in cross section flow area that results from a skewed bridge section. The project would be very costly and result in only a modest reduction in flooding.	**N**
A-4: Reduce roughness from County Route 6 bridge to Route 42 bridge.	Reducing the Manning's roughness coefficients in the HEC-RAS model simulates the clearing of vegetation within the channel and along the banks. The roughness coefficients along both banks through this reach were changed from 0.060 to 0.045 to represent clearing of vegetation. The revision of roughness coefficients had little to no impact on predicted water surface elevations.	**N**
A-5: Reduce roughness from Route 42 bridge to parcel 144.00-1-22.	The roughness coefficients along both banks through this reach were changed from 0.060 to 0.045 to represent clearing of vegetation. The revision of roughness coefficients had little to no impact on predicted water surface elevations.	**N**
A-6: Sediment removal from County Route 6 bridge to Route 42 bridge.	Removal of sediments through this section by a maximum of 2 feet would reduce water surface elevations by at most 0.8 foot at a point just upstream of the Route 42 bridge.	**N**
A-7: Sediment removal from Route 42 bridge to parcel 144.00-1-22.	HEC-RAS geometry through this reach does not indicate significant sediment accumulation within the channel. Proposed geometry simulates grading of a lower low-flow channel by approximately 1 foot. Sediment removal has a negligible effect on predicted water surface elevations.	**N**



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ALTERNATIVES: STUDY AREA B

LEXINGTON LFHMA

HAMLET OF LEXINGTON
LEXINGTON, NEW YORK

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MXD: Y:\2884-03\Maps
1st Version: 4/1/2014
Revision:
Scale: 1 in = 700 ft

Figure 4-2

TABLE 4-2
Flood Mitigation Alternatives
Study Area B – Lexington Hamlet

Alternative	Notes	Recommended for Further Evaluation?
B-1: Replace existing Route 42 bridge over Schoharie Creek.	Predicted 100-year water surface elevations are unchanged downstream of the replaced bridge, but this alternative effectively lowers water surface elevations upstream of the bridge, tying into existing elevations nearly 3,500 feet upstream of the crossing. The greatest reductions in elevations are seen within 2,100 feet upstream of the replaced bridge.	**Y**
B-2: Replace existing Route 42 bridge over West Kill ("Basil Bridge").	Bridge is to be replaced by NYSDOT; MMI is to provide recommendations for sizing of new bridge.	**N**
B-2a: Supplement culvert under Route 42.	A larger culvert at this location does not reduce flooding but helps area drain more quickly after a flood.	**N**
B-2b: Construct levee at Basil property.	Levee would be located within FEMA floodway. There would be no placement of fill/increase in water surface elevations in the floodway.	**N**
B-3: Replace Van Valkenburgh Road bridge over West Kill (bridge was washed out in Irene).	Modeling with bridge in place indicates that the bridge acted as a hydraulic constriction and caused increase in water surface elevation; its replacement is not recommended. Any remaining bridge abutments should be removed.	**N**
B-4: Replace existing Route 42 bridge over West Kill near Beech Ridge Road.	The removal of the Route 42 bridge at Beech Ridge Road has a negligible effect on predicted 100-year water surface elevations.	**N**
B-5: Create floodplain along north side of Schoharie Creek.	This alternative was divided into two alternatives. See options B-5a and B-5b.	
B-5a: Grade up to the south edge of 13a.	This alternative results in decreases in predicted 100-year water surface elevations extending 1,100 feet downstream of Route 42. The maximum predicted decrease, 1.6 feet, would occur at the downstream face of the Route 42 bridge. Approximately 200 feet downstream of the bridge, the predicted 100-year water surface elevation decrease results in a decrease in lateral flooding extent of approximately 45 feet. Farther downstream, however, the floodplain extents are barely reduced despite the reduction in water surface elevation. The floodplain grading has little impact on predicted elevations for the 10- and 50-year storms.	**Y**

Alternative	Notes	Recommended for Further Evaluation?
B-5b: Grade up through 13a and establish new road or alternate access.	This alternative would involve major reworking of Lexington Hamlet and was judged to be too intrusive.	**N**
B-6: Create wider, lower floodplain along south side of Schoharie Creek.	This alternative was divided into two alternatives. See options B-6a and B-6b.	
B-6a: Upstream of the Route 42 bridge	The existing left bank floodplain upstream of the Route 42 bridge is fairly well developed and does not offer much room for regrading. The waterward slope from Rappleyea Road is very steep and could not be regraded.	**N**
B-6b: Downstream of the Route 42 bridge	Downstream of Route 42, the left floodplain can be further excavated to increase capacity.	**Y**
B-7: Create wider, lower floodplain along south side of West Kill.	The West Kill channel between RS 1.3257 and RS 1.12032 (Section C) is significantly narrower than in upstream reaches. It is confined on its left bank by Route 42 and on its right bank by a steep, vegetated slope. The Route 42 bridge and downstream roadway were replaced in 2012 following washouts during Tropical Storm Irene. Although this alternative shows a reduction in water surface elevations, the constructability of the floodplain shelf in this area and the safety concerns with disturbing the already unstable slope may make this option infeasible.	**N**
B-8: Lower the floodplain along the south side of West Kill, staying mostly north of the road but including some land south of the road at the bridge alignment.	In order to achieve any appreciable decreases in predicted water surface elevations, excavation would have to extend into the properties located downstream of the former Van Valkenburgh bridge location. The floodplain excavation effectively reduces flooding over Route 42 during the 100-year storm but also requires the removal of many residences. The predicted benefit to roadway flooding may not justify the demolition of these private structures.	**N**
B-9: Reduce roughness along Schoharie Creek where farmland was present long ago.	While this alternative shows some reduction in water surface elevations, it is not a sustainable solution to flood problems and would likely result in floodplain instability and an increase in sediment loads.	**N**
B-10: Reduce roughness along Schoharie Creek floodplain.	While this alternative shows some reduction in water surface elevations, it is not a sustainable solution to flood problems and would likely result in floodplain instability and an increase in sediment loads.	**N**

Alternative	Notes	Recommended for Further Evaluation?
B-11: Reduce roughness along West Kill between the two Route 42 bridges.	Modeling does not show a decrease in water surface elevations.	**N**
B-12: Sediment removal from main channel of Schoharie Creek upstream of West Kill	Minor sediment removal would have little effect on water surface elevations. It is not clear if major dredging operations at the bridge crossing would be feasible or warranted. The channel could theoretically be lowered by nearly 9.5 feet, but this would most likely expose the footings of the bridge and may not be feasible if bed grades are controlled by bedrock rather than sediment accumulation.	**N**
B-13: Sediment removal from the main channel of West Kill	Proposed channel sections were regraded by approximately 1 foot to lower the low-flow channel or more to create a more constant bed slope. Predicted water surface elevations remain nearly unchanged.	**N**
B-14: Sediment removal from main channel of Schoharie Creek downstream of West Kill	The profile view of the river and aerial photography clearly show an accumulation of material at this confluence. The modeled alternative removes this large deposition of sediment at the confluence, but even with nearly 10 feet of sediment removal, water surface elevations for the 100-year storm are only decreased by 0.8 foot at this reach.	**N**

4.4 Evaluation Results

The flood mitigation alternatives evaluated in West Kill only minimally reduce water surface elevations on roadways or private properties or not at all. Alternative A-3 reduces 100-year water surface elevations 1.5' to 3.4' along Spruceton Road, but the mitigation action encroaches on many homes and requires that several be removed. Without homes remaining in place to enjoy the benefit of reduced water surface elevations, the alternative lacks justification.

Most of the flood mitigation alternatives in Lexington Hamlet appear to minimally reduce water surface elevations on roadways or private properties or do not reduce water surface elevations. Some of the alternatives are too disruptive to more than a few private properties.

Several of the alternatives in Lexington Hamlet have merit and were evaluated more closely. These are discussed below in more detail.

Alternative B-1: Replacement of Existing Route 42 Bridge Over Schoharie Creek

Replacement of the Route 42 bridge with an adequately sized structure capable of passing flood flows effectively lowers water surface elevations upstream of the bridge for a distance of nearly 3,500 feet upstream of the crossing. The greatest reductions in elevations are seen within 2,100 feet upstream. Reductions in water surface elevation at key points in the channel are summarized in Table 4-3.

TABLE 4-3
Alternative B-1 Water Surface Elevation Reductions

Effect on Water Surface Elevations (reduction in feet)			
Distance from Route 42 bridge	**10-year**	**50-year**	**100-year**
upstream face	0.95	1.75	0.8
500' upstream	0.42	1.77	1.03
950' upstream	0.27	1.49	0.89
1,390' upstream	0.11	1.12	0.69
2,150' upstream	---	0.62	0.44
2,750 ' upstream	---	0.17	0.12

Alternative B-5a: Create Floodplain Bench Along North Side of Schoharie Creek

The excavation of a floodplain bench along the north bank of Schoharie Creek downstream of the Route 42 bridge results in decreases in predicted 100-year water surface elevations extending 1,100 feet downstream of Route 42. The maximum predicted decrease, 1.6 feet, would occur at the downstream face of the Route 42 bridge. Reductions in water surface elevation at key points in the channel are summarized in Table 4-4.

TABLE 4-4
Alternative B-5a Water Surface Elevation Reductions

Effect on Water Surface Elevations (reduction in feet)			
Distance from Route 42 bridge	**10-year**	**50-year**	**100-year**
3,825' upstream	0.00	0.00	0.00
2,170' upstream	0.05	0.90	0.00
1,120' upstream	0.31	2.22	0.00
285' upstream	1.34	3.79	0.00
upstream face	1.57	1.93	0.00
downstream face	1.73	1.84	2.74
215' downstream	1.76	1.83	1.94
960' downstream	0.18	0.59	0.89
1,560' downstream	0.32	0.45	0.51
2,175' downstream	0.00	0.00	0.00

Combination of Alternatives B-1 and B-5a

The creation of a floodplain bench on the north side of Schoharie Creek was combined with the replacement of the Route 42 bridge. The effects on water surface elevations are summarized in Table 4-5.

TABLE 4-5
Combination of Alternatives B-1 and B-5a
Water Surface Elevation Reductions

Effect on Water Surface Elevations (reduction in feet)			
Distance from Route 42 bridge	**10-year**	**50-year**	**100-year**
2,620' upstream	0.00	0.00	0.00
1,700' upstream	0.37	0.63	0.75
800' upstream	0.82	0.68	0.75
upstream face	1.33	1.39	1.55
downstream face	1.19	0.30	0.55
350' downstream	0.81	3.98	3.22
820' downstream	0.63	2.93	2.45
1,120' downstream	0.44	1.65	1.43
2,720' downstream	0.00	0.00	0.00

Alternative B-6b: Create Floodplain Along South Side of Schoharie Creek, Downstream of Bridge

Creation of a wider, lower floodplain was assessed along the south side of Schoharie Creek downstream of the Route 42 bridge. The effects on water surface elevations are summarized in Table 4-6.

TABLE 4-6
Alternatives B-6b
Water Surface Elevation Reductions

Effect on Water Surface Elevations (reduction in feet)			
Distance from Route 42 bridge	**10-year**	**50-year**	**100-year**
3,540' upstream	0.00	0.00	0.00
1,700' upstream	0.15	1.50	0.00
800' upstream	0.70	2.84	0.01
upstream face	1.52	4.82	0.00
downstream face	1.61	1.42	2.37
350' downstream	1.88	1.90	1.88
820' downstream	2.04	1.78	1.65
1,120' downstream	0.23	0.53	0.83
2,760' downstream	0.00	0.00	0.00

Combination of Alternatives B-1 and B-6b

The creation of a floodplain bench on the south side of Schoharie Creek was combined with the replacement of the Route 42 bridge. The effects on water surface elevations are summarized in Table 4-7.

TABLE 4-7
Combination of Alternatives B-1 and B-6b
Water Surface Elevation Reductions

Effect on Water Surface Elevations (reduction in feet)			
Distance from Route 42 bridge	**10-year**	**50-year**	**100-year**
3,540' upstream	0.00	0.00	0.00
1,700' upstream	0.46	1.75	1.59
800' upstream	0.70	3.26	2.89
upstream face	0.99	4.45	3.87
downstream face	1.76	0.90	1.20
350' downstream	1.87	1.98	2.02
820' downstream	2.00	1.76	1.63
1,120' downstream	0.18	0.50	0.79
2,760' downstream	0.00	0.00	0.00

4.5 Property-Specific Mitigations and Relocations

The majority of properties in Lexington Hamlet that are currently in the SFHA *will remain* in the SFHA even if the flood mitigation alternatives described above were fully implemented. Likewise, the properties in the floodway will remain in the floodway. Properties in the SFHA and floodway will therefore be subject to continued flood risk and flood insurance coverage requirements[1]. However, the reduction of flood water surface elevations in Lexington Hamlet would have two benefits:

1. Depth of actual flooding may decrease in future floods, leading to reduced damages and reduced time and costs for cleanup and recovery.
2. Reduced water surface elevations can be used to support a Letter of Map Revision (LOMR[2]) or physical map revision (PMR[3]), which would formally reduce the BFE and may reduce flood insurance premiums.

[1] Flood insurance requirements are dependent on status of the property relative to loans, mortgages, or other factors that are outside the scope of this plan.
[2] A LOMR is FEMA's modification to a FIRM. LOMRs are generally based on the implementation of measures that affect the hydrologic or hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodway, the effective BFEs, or the SFHA. The LOMR officially revises the FIRM without causing

Property-specific flood mitigation options should be pursued in Lexington Hamlet near West Kill Creek in the area depicted in Figure 4-3. Examples of flood mitigation options in this area include removing or elevating the buildings from 3589 Route 42 to 3617 Route 42 on the north side of the road and the buildings from Basil Road past the town hall on the south side of the road.

Figure 4-3: Lexington Hamlet Near West Kill Creek

Property-specific flood mitigation options should be pursued in West Kill Hamlet near West Kill Creek in the area depicted in Figure 4-4. Examples include removing or elevating the buildings at 2493 Route 42, 2486 Route 42, 2516 Route 42, 173 Spruceton Road, 161 Spruceton Road, 141 Spruceton Road (Community Hall), and 2521 Route 42.

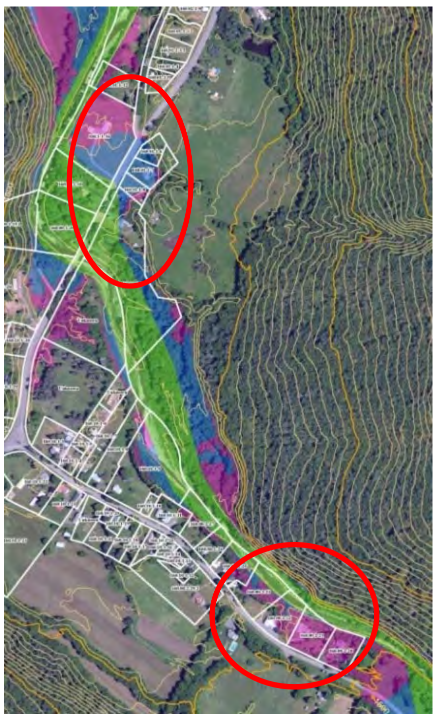


Figure 4-4: West Kill Hamlet Near West Kill Creek

FEMA to republish the FIRM. The LOMR is generally accompanied by an annotated copy of the affected portions of the FIRM.

[3] A PMR is an action whereby one or more FIRM or DFIRM map panels are physically revised and republished. A PMR is used to change flood risk zones, floodplain and/or floodway delineations, flood elevations, and/or planimetric features. A LOMR accomplishes some of the same changes as the PMR, but the FIRM or digital flood insurance rate map (DFIRM) panels are not republished with the LOMR.

The basic choice at each property will be to determine whether a building should be removed and the parcel converted to open space or mitigated through elevation, floodproofing, elevating utilities, etc. as described below[4].

If homes are elevated, they will need to be elevated 2 feet above the BFE. However, this will present an important question to property owners that would benefit from the creation of the floodplain bench or from the replacement of the Route 42 bridge – should the current BFE be applied, or should the work be postponed to take advantage of a future (and lower) BFE defined by a LOMR or PMR? In many cases, a property owner may not have time available to delay a building elevation, floodproofing project, or utility elevation. However, if the property owner can delay a mitigation project until after the Town of Lexington has secured a LOMR or PMR, then the design elevation may be lower.

A variety of measures are available to protect existing public and private properties from flood damage. While broader mitigation efforts are desirable such as those described above, they often take time and significant funding to implement. On a case-by-case basis, individual floodproofing should be explored where structures are at risk. Potential measures for property protection include the following:

<u>Elevation of the structure (residential or nonresidential buildings).</u> Home elevation involves the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located above the level of the 100-year flood event. The basement area is abandoned and filled to be no higher than the existing grade. All utilities and appliances located within the basement must be relocated to the new elevated first-floor level.

<u>Dry floodproofing of the structure to keep floodwaters from entering (nonresidential buildings).</u> Dry floodproofing refers to the act of making areas below the flood level watertight. Walls may be coated with compound or plastic sheathing. Openings such as windows and vents would be either permanently closed or covered with removable shields. Flood protection should extend only 2 to 3 feet above the top of the concrete foundation because building walls and floors cannot withstand the pressure of deeper water. Dry floodproofing is not appropriate for residential structures but is permissible for nonresidential structures.

<u>Wet floodproofing of the structure to allow floodwaters to pass through the lower area of the structure unimpeded (nonresidential buildings).</u> Wet floodproofing refers to intentionally letting floodwater into a building to equalize interior and exterior water pressures. Wet floodproofing should only be used as a last resort. If considered, furniture and electrical appliances should be moved away or elevated above the 100-year flood elevation. Wet floodproofing is not appropriate for residential structures unless accomplished by elevating the structure as described above but is permissible for nonresidential structures.

[4] Substantial damage or a substantial improvement will trigger elevation of residential buildings and either dry floodproofing or elevation of nonresidential buildings.

Construction of property improvements such as barriers, floodwalls, and earthen berms. Such structural projects can sometimes be used to prevent flooding. There may be properties within the town where implementation of such measures will serve to protect structures. For example, the Third Brook Watershed Management Plan discusses the merits of constructing a floodwall on the Kraft property to protect the building and some of the exterior assets from flooding.

Performing other home improvements to mitigate damage from flooding (residential or nonresidential buildings). The following measures can be undertaken to protect home utilities and belongings:

- Relocate valuable belongings above the 100-year flood elevation to reduce the amount of damage caused during a flood event.
- Elevate the electrical box or relocate it to a higher floor and elevate electric outlets to at least 12 inches above the high water mark.
- Relocate or elevate water heaters, heating systems, washers, and dryers to a higher floor or to at least 12 inches above the high water mark (if the ceiling permits). A wooden platform of pressure-treated wood can serve as the base.
- Anchor a fuel tank to the wall or floor with noncorrosive metal strapping and lag bolts.
- Install a backflow valve to prevent sewer backup into the home.
- Install a floating floor drain plug at the lowest point of the lowest finished floor.

Encouraging property owners to purchase flood insurance under the National Flood Insurance Program (NFIP) and to make claims when damage occurs. While having flood insurance will not prevent flood damage, it will help a family or business put things back in order following a flood event. Property owners should be encouraged to submit claims under the NFIP whenever flooding damage occurs in order to increase the eligibility of the property for projects under the various mitigation grant programs.

4.6 Other Flood Concerns

During both public meetings that were held in connection with the LFA for the town of Lexington, residents in Lexington Hamlet explained that properties along Route 23A and Banks Road experienced yard flooding and minor flooding of buildings during Irene. The area that flooded is depicted in Figure 4-5. They also explained that the flooding was caused by runoff from the hillside and streams flowing from the hillside, under Route 23A, and into Schoharie Creek. Upon further investigation of this area, it appears that overbank flooding from the creek likely extends up to and through the culverts beneath the road. This would cause backwater conditions and lead to flooding of

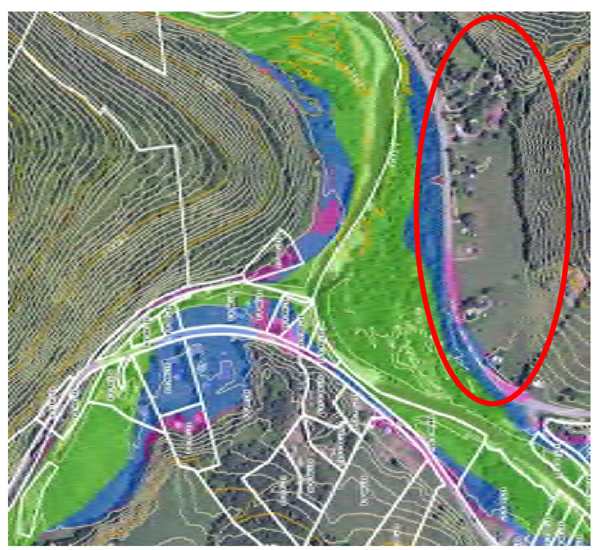


Figure 4-5: Area of Flooding

the small tributaries, which would have also been carrying floodwaters from the intense precipitation.

The particular set of circumstances in this small neighborhood is not appropriate for evaluating using the existing hydraulic models. Flood mitigation in this area may include a combination of property-specific options (elevations of homes) and structural projects that help convey the tributaries under the highway to Schoharie Creek while preventing backwater flooding from the overbank conditions along Schoharie Creek.

However, it is important to note that there may not be a design that can completely prevent future flooding that is similar to the level experienced during Irene. Future evaluations may need to explore solutions that would be feasible under more frequent, small floods. Additionally, future evaluations should consider whether the timing of the flood hydrograph in the tributary streams is sufficiently offset from the timing of the flood hydrograph of Schoharie Creek as this may allow some creativity in the design at this location. For example, it may be possible to convey high discharges in the tributaries under the road prior to the peak of flooding along Schoharie Creek and then partially obstruct floodwaters from Schoharie Creek from backing up the culverts.

4.7 Limited Stream Stabilization

During both public meetings that were held in connection with the LFA for the town of Lexington, residents in West Kill explained that significant channel migration and bank erosion had occurred – and was still occurring – upstream of the Route 42 bridge and parallel to Spruceton Road. This area is depicted in Figure 4-6. Because this channel migration and erosion is not *currently* threatening any buildings and is not affecting the limits of the flood risk zones, it is not a typical area of review for the LFA program. However, to the extent that the channel migration and erosion might threaten the integrity of the bridge, it is appropriate to include consideration of the channel migration in this report.

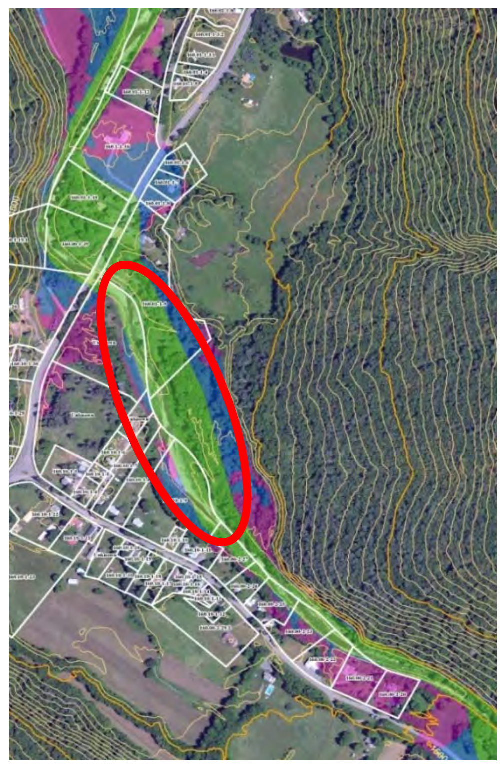


Figure 4-6: Area of Channel Migration and Bank Erosion

Detailed study of this section of West Kill Creek is outside the scope of the LFA, but future studies may demonstrate that changes in the creek could undermine the bridge by eroding the banks where they meet the abutments. The bridge is a critical section of transportation infrastructure in the town. If necessary, it is recommended that the town consider stream stabilization along West Kill Creek upstream of the Route 42 bridge in West Kill Hamlet. This will help protect the bridge from structural damage during future floods.

5.0 BENEFIT-COST ANALYSIS

5.1 Overview of Benefit-Cost Analysis

A Benefit-Cost Analysis (BCA) is used to validate the cost effectiveness of a proposed hazard mitigation project. A BCA is a method by which the future benefits of a project are estimated and compared to its cost. The end result is a benefit-cost ratio (BCR), which is derived from a project's total net benefits divided by its total project cost. The BCR is a numerical expression of the cost effectiveness of a project. A project is considered to be cost effective by FEMA when the BCR is 1.0 or greater, indicating the benefits of the project are sufficient to justify the costs. A BCA was conducted for proposed alternatives that based on evaluation of the HEC-RAS modeling would result in reduced flooding and would not have an unacceptable impact on the community.

BCA was conducted for the following alternatives and combinations of alternatives:

- Alternative B-1: Replacement of existing Route 42 bridge over Schoharie Creek
- Alternative B-5a: Create floodplain along north side of Schoharie Creek with grading up to the south side of Route 13A.
- Alternative B-6b: Create floodplain along south side of Schoharie Creek downstream of bridge.
- Combination of Alternatives B-1 and B-5a: Replace bridge and create floodplain.
- Combination of B-1 and B-6b: Replace bridge and create floodplain.

Given the number of individual properties involved (more than 30) compared to the number of projects, the BCA methodology relied on the determination of sets of benefits for each property. The benefits were then summed outside of the BCA program and compared to the costs of the five alternatives. The weakness to this method is that it neglects the maintenance costs for mitigation projects, which are typically estimated (for example, $500 per year for floodplain bench "maintenance") and assigned a present value by the BCA program. However, the magnitude of the benefits and costs in Lexington (discussed below) are so much greater than the present value of maintenance costs that they can be neglected for this analysis.

Other factors and assumptions for the BCA include the following:

- Benefits for acquired/relocated properties were determined as acquisitions.
- Benefits for all other properties (the majority of those considered) were generated as local flood reduction projects.
- Lost revenue was not included for any businesses (for example, the Lexington Hotel) because the affected properties are primarily residential.
- Default depth-damage curves were used in the program.
- Existing and future water surface elevations were determined from the HEC-RAS output at cross sections. For any given building, the nearest cross section was used.
- First-floor elevations were estimated using Light Detection and Ranging (LiDAR) topographic mapping for some properties except when available from the sewer system plans or when surveyed for other reasons.

- Adjustments to the LiDAR topography were made for buildings based on direct observations of first floors relative to adjacent grades.
- Building replacement values were based on the assessed values and square footages provided by the Greene County Planning Department's Geographic Information System (GIS) database.

The BCA does not include benefits that could have been generated for avoiding future street cleanup, avoided detours, avoided emergency response, water quality impacts, etc.

5.2 BCA Results

Alternative B-1

BCA results for Alternative B-1, replacement of the Route 42 bridge, are presented in Table 5-1.

TABLE 5-1
Alternative B-1 Benefit-Cost Analysis

Benefits	
Reduced flood depths at structures that remain in place[1]	$38,248
Avoided flooding at four homes that are removed to complete project	$0
Avoided flooding at the hotel (also removed to complete project)	$0
Total Benefits	**$38,248**
Estimated Cost	**$4,624,000**
Benefit-Cost Ratio	**0.01**

1. First-floor elevations are based on LiDAR topographic mapping and corrected with sewer system plans.

For this alternative, the total benefits of $38,248 were derived from reduced water surface elevations at the homes located upstream of the bridge. This figure represents a lower cost in flood cleanup and repair at numerous homes projected over 50 years.

Alternative B-5a

Alternative B-5a entails the excavation of a floodplain along the north side of Schoharie Creek with grading up to the south side of Route 13A. Results of the BCA are presented in Table 5-2.

TABLE 5-2
Alternative B-5a Benefit-Cost Analysis

Benefits	
Reduced flood depths at structures that remain in place[1]	$141,162
Avoided flooding at relocated home	$177,598
Avoided flooding at relocated Lexington Hotel	$1,201,474[2]
Total Benefits	$1,520,234
Estimated Cost	$2,085,200
Benefit-Cost Ratio	**0.73**

1. First-floor elevations are based on LiDAR topographic mapping, sewer system plans, and building elevation surveys.
2. Removal of hotel alone, without any other mitigation project, may have a benefit-cost ratio above 1.0 in the context of FEMA mitigation grants.

For this alternative, the total benefits of $141,162 were derived from reduced water surface elevations at the homes located on Route 13A north of the floodplain bench. This figure represents a lower cost in flood cleanup and repair at these homes. The benefits of $177,598 were derived from completely avoided flood damages where a home was once located. Similarly, the benefits of $1,201,474 were derived from completely avoided flood damages where the hotel was located.

One compelling aspect of this alternative is that the benefits are heavily weighted by the removal of buildings that are incidental to creating the floodplain bench. The floodplain bench itself does not directly generate the larger portion of benefits. Nevertheless, the alternative is a single project, and the BCA is valid if the total benefits are considered.

Combination of Alternatives B-1 and B-5a

Alternatives B-1 and B-5a were combined, and the results of the BCA are presented in Table 5-3.

TABLE 5-3
Combination of Alternatives B-1 and B-5a
Benefit-Cost Analysis

Benefits	
Reduced flood depths at structures that remain in place[1]	$157,208
Avoided flooding at relocated home	$177,598
Avoided flooding at relocated hotel	$1,201,474[2]
Total Benefits	**$1,536,280**
Estimated Cost	**$6,709,100**
Benefit-Cost Ratio	**0.23**

1. First floor elevations are based on LiDAR topographic mapping, sewer system plans, and building elevation surveys.
2. Removal of hotel alone, without any other mitigation project, may have a benefit-cost ratio above 1.0 in the context of FEMA mitigation grants.

For this alternative, the total benefits of $157,208 were derived from reduced water surface elevations at the homes located on Route 13A north of the floodplain bench and homes located upstream of the bridge. This figure represents a lower cost in flood cleanup and repair at these homes. The benefits of $177,598 were derived from avoided flood damages where homes were once located, and the benefits of $1,201,474 were derived from avoided flood damages where the hotel was located.

The relatively low BCR is the result of adding a costly mitigation project (bridge replacement) to a less costly mitigation project (the floodplain bench). The cost increase was proportionally higher than the increase in benefits, and the BCR dropped relative to the BCR for Alternative B5a.

Alternative B-6b

BCA results for Alternative B-6b, creation of a floodplain along left bank of Schoharie Creek downstream of Route 42 bridge, are presented in Table 5-4.

TABLE 5-4
Alternative B-6b
Benefit-Cost Analysis

Benefits	
Reduced flood depths at structures that remain in place[1]	$410,359
Avoided flooding at relocated homes[2]	$0
Avoided flooding at relocated hotel[2]	$0
Total Benefits	**$410,359**
Estimated Cost	**$2,280,890**
Benefit-Cost Ratio	**0.18**

1. First floor elevations are based on LiDAR topographic mapping, sewer system plans, and building elevation surveys.
2. Removal of buildings is not necessary for left bank floodplain bench.

For this alternative, the total benefits of $410,359 were derived from reduced water surface elevations at the homes located along the new floodplain bench. This figure represents a lower cost in flood cleanup and repair at these homes.

Combination of Alternatives B-1 and B-6b

Alternatives B-1 and B-6b were combined. The results of the BCA are presented in Table 5-5.

TABLE 5-5
Combination of Alternatives B-1 and B-6b
Benefit-Cost Analysis

Benefits	
Reduced flood depths at structures that remain in place[1]	$432,396
Avoided flooding at relocated homes[2]	$0
Avoided flooding at relocated hotel[2]	$0
Total Benefits	**$432,396**
Estimated Cost	**$6,904,790**
Benefit-Cost Ratio	**0.06**

1. First floor elevations are based on LiDAR topographic mapping, sewer system plans, and building elevation surveys.
2. Removal of buildings is not necessary for left bank floodplain bench.

For this alternative, the total benefits of $432,396 were derived from reduced water surface elevations at the homes located along the new floodplain bench and homes located upstream of the bridge.

TABLE 5-6
Comparison of Benefits
Bridge Replacement and Right Floodplain

Comparison of Benefits	**B-1 Bridge**	**B-5a Right Floodplain**	**Combo B-1 and B-5a**
Reduced flood depths at 30 homes that remain in place[1]	$38,248	$141,162	$157,208
Avoided flooding at relocated home	$0	$177,598[2]	$177,598[2]
Avoided flooding at relocated Lexington Hotel	$0	$1,201,474[2]	$1,201,474[2]
Total Benefits	**$38,248**	**$1,520,234**	**$1,536,280**
Estimated Cost	**$4,624,000**	**$2,085,200**	**$6,709,100**
Benefit-Cost Ratio	**0.01**	**0.73**	**0.23**

1. First floor elevations are based on LiDAR topographic mapping, sewer system plans, and building elevation surveys.
2. Removal of buildings alone without any other mitigation project may have benefit-cost ratios above 1.0 in the context of FEMA mitigation grants.

TABLE 5-7
Comparison of Benefits
Bridge Replacement and Left Floodplain

Comparison of Benefits	B-1 Bridge	B-6b Left Floodplain	Combo B-1 and B-6b
Reduced flood depths at 30 homes that remain in place[1]	$38,248	$410,359	$432,396
Avoided flooding at relocated homes[2]	$0	$0	$0
Avoided flooding at relocated Lexington Hotel[2]	$0	$0	$0
Total Benefits	**$38,248**	**$410,359**	**$432,396**
Estimated Cost	**$4,624,000**	**$2,280,890**	**$6,904,790**
Benefit-Cost Ratio	**0.01**	**0.18**	**0.06**

1. First floor elevations are based on LiDAR topographic mapping, sewer system plans, and building elevation surveys.
2. Removal of buildings is not necessary for left bank floodplain bench.

Although Alternative B-6b generated higher benefits than Alternative B-5a for homes that remain in place, the total benefits are higher for B-5a due to the acquisitions required to construct the project.

One of the major drawbacks to Alternative B-6b is that the earthwork would be more disruptive to the sewer main under Schoharie Creek as compared to the earthwork needed for Alternative B-5a. Simply stated, a longer span of the sewer main would need to be lowered to construct Alternative B-6b when compared to Alternative B-5a. These costs are not considered in the BCA described above, but they would reduce the BCRs for Alternative B-6b, Alternative B-5a, and the combinations.

The BCA does not include consideration of water quality benefits that could be provided by flood mitigation projects. Water quality benefits should be used to increase benefits when the BCR is poorly represented by the flood reduction benefits generated by the BCA program or when stratification or prioritization of mitigation projects is difficult due to a calculation of similar BCRs.

Appendix B includes a memorandum that discusses two potential approaches that can be used to include water quality benefits in future BCA. With reference approach #1 (refer to the bottom of page 3 of the memorandum), no alternatives have BCRs above 0.75; therefore, none of the alternatives are appropriate candidates for assistance from water quality benefits. The closest alternative, B-5a, has a BCR of 0.73.

6.0 FINDINGS, RECOMMENDATIONS, AND IMPLEMENTATION

6.1 Summary of Findings

The LFA completed for Lexington has demonstrated that several flood mitigation projects have merit because they will reduce flood water surface elevations in Lexington Hamlet near the intersection of Route 42 and 13A. These projects largely depend on the construction of a lower floodplain (or floodplain bench) coupled with replacement of the Route 42 bridge and a handful of strategic building removals to facilitate the floodplain bench creation. However, a parallel combination of flood mitigation projects such as floodplain benches and bridge replacements is not feasible for reducing flood risk in West Kill Hamlet.

Aside from the alternatives that were considered, there may be other key businesses, critical facilities, or residential buildings in the town of Lexington that can be relocated from zones of flood risk. This LFA supports the relocation of any critical facility that is currently at risk of flooding or will continue to be exposed to residual risk. If private property owners are interested in relocating elsewhere in the town, the buyout program could be used to facilitate relocations that are not part of the proposed alternatives. The Town Board may, at its discretion, seek to acquire the most flood-vulnerable properties where there is owner interest and programmatic funding available either through FEMA or NYCDEP. Such properties would need to be approved by the Town Board for acquisition consideration.

Individual property owners will be required to elevate or floodproof their properties over time as substantial damage or substantial improvement thresholds are triggered. However, optional elevations and floodproofing may be desired in strategic locations where unacceptable flood risk remains after floodplain and bridge replacement projects are implemented. This will have the dual benefit of reducing flood risks while reducing flood insurance premiums for those properties that are insured.

Creation of extensive floodwalls and levees is not supported by this LFA, nor is extensive sediment removal from the rivers. Widespread removal of buildings from either hamlet is also not supported by the LFA as the community would suffer from the disruption to its population centers.

6.2 Recommendations

The following flood mitigation recommendations are offered:

1. Proceed with comprehensive flood mitigation in Lexington Hamlet center through the projects described in this LFA (acquire and remove home on south side of Route 13A, acquire and remove Lexington Hotel, lower the sewer pipe between Route 13A and Schoharie Creek, create floodplain bench, and replace Route 42 bridge). Consider supporting eligible landowners in relocating out of the floodway and remaining within the municipality.

2. Consider and pursue flood mitigation for properties along Route 23A and Banks Road where backwater conditions extend from Schoharie Creek through culverts under Route 23 while

tributaries may flood in the vicinity of these culverts. Mitigation may include property-specific options (elevations) and conveyance/backwater mitigation projects.

3. Pursue property-specific flood mitigation options in Lexington Hamlet near West Kill Creek. Examples include removing or elevating the buildings from 3589 Route 42 to 3617 Route 42 on the north side of the road and the buildings from Basil Road past the town hall on the south side of the road. The choice of acquisition vs. elevation will depend on the position of each building relative to the West Kill Creek floodway.

4. Pursue property-specific flood mitigation options in West Kill Hamlet near West Kill Creek. Examples include removing or elevating the buildings at 2493 Route 42, 2486 Route 42, 2516 Route 42, 173 Spruceton Road, 161 Spruceton Road, 141 Spruceton Road (Community Hall), and 2521 Route 42. The choice of acquisition vs. elevation will depend on the position of each building relative to the West Kill Creek floodway.

5. Consider elevation of homes on a case-by-case basis as property owners approach the Lexington Flood Commission and/or the Town about mitigation. Ensure that elevations are conducted in accordance with the effective BFE at the time of the work.

6. If necessary, consider and pursue stream stabilization along West Kill Creek upstream of the Route 42 bridge in West Kill Hamlet. This will help protect the bridge from structural damage during future floods.

7. In the State of New York, since 2007, the lowest floor including any basement must be at or above the base flood elevation *plus 2 feet*. The Town of Lexington flood damage prevention code should be updated to meet the State of New York standards.

8. The town should identify parcels as part of a communitywide pollution protection program which could benefit from securing or relocating fuel tanks to eliminate a potential source of man-made pollution and apply for funding through the CWC.

9. The Town of Lexington should apply for a grant through the Catskill Watershed Corporation's Sustainable Communities Planning Program to identify areas within the municipality that may serve as new locations should any residences and/or businesses be purchased under the voluntary NYC Flood Buyout Program or the FEMA Hazard Mitigation Grant Assistance Program.

The following procedural recommendations are offered:

- ❑ During and after future floods, record and compile municipal, county, and state costs related to cleanup and recovery in Lexington. This may help improve future BCA determinations.

- ❑ Identify opportunities to include water quality benefits in future BCA determinations. This may be particularly helpful when costs exceed standard flood mitigation benefits by narrow margins.

6.3 Implementation Plan

Lexington Hamlet – Figure 6-1 presents a general overview of potential pathways that can be taken in Lexington for flood mitigation in the hamlet center through the projects described in this LFA (acquire and remove home on south side of Route 13A, acquire and remove Lexington Hotel, lower the sewer pipe between Route 13A and Schoharie Creek, create floodplain bench, and replace Route 42 bridge).

Figure 6-1
Implementation Framework for Mitigation Projects in the Center of Lexington Hamlet

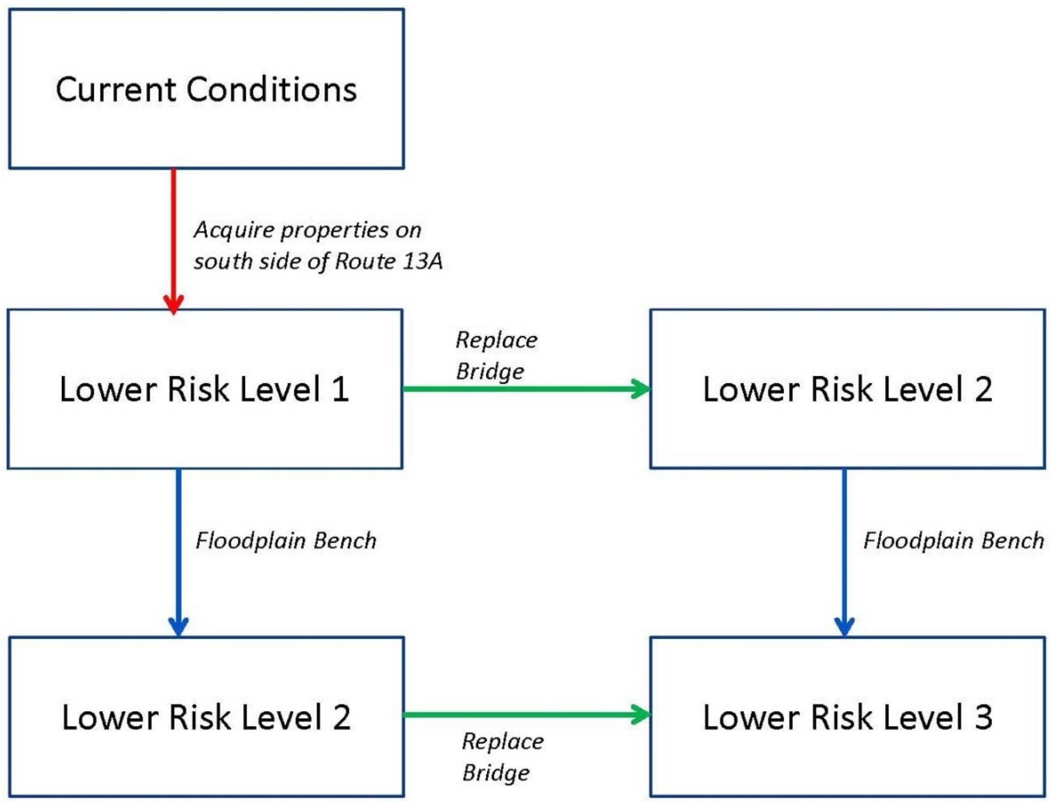


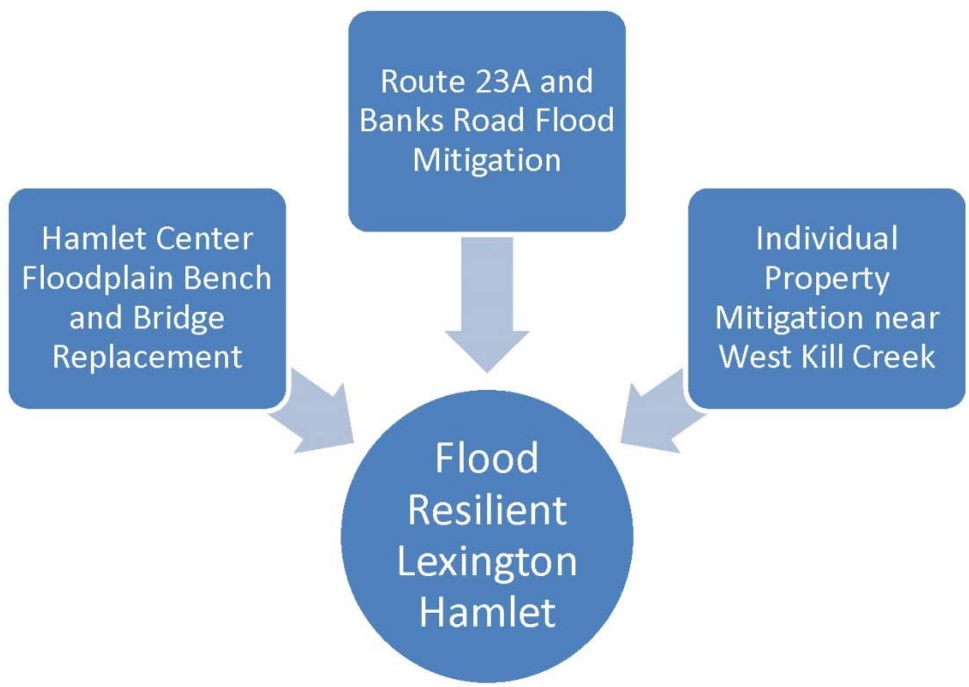
Figure 6-1 depicts the desired outcome of flood mitigation projects: lower risk level "3" which includes building acquisitions, a floodplain bench, and bridge replacement. In all cases, mitigation will begin with the acquisitions as they will take less time and are eligible for a greater number of funding sources. The longer-term portions of the project rely on floodplain bench creation and bridge replacement. Bridge replacement in particular will occur sometime in the future although the date is not known.

For properties along Route 23A and Banks Road, mitigation of backwater conditions that extend from Schoharie Creek through culverts under the road should be pursued as one project to reduce risk to all homes in this area simultaneously. However, this project can proceed separately from the mitigation projects in the hamlet center.

Additional flood mitigation options in Lexington Hamlet are available near West Kill Creek but are unrelated to one another because they will result in lower risks mainly to the buildings being acquired or elevated. Examples include the buildings from 3589 Route 42 to 3617 Route 42 on the north side of the road and the buildings from Basil Road past the town hall on the south side of the road.

Figure 6-2 depicts the relationship between all of the mitigation projects in Lexington Hamlet. If flood mitigation projects of all types are completed throughout the hamlet, the community will be more resilient when the next flood occurs.

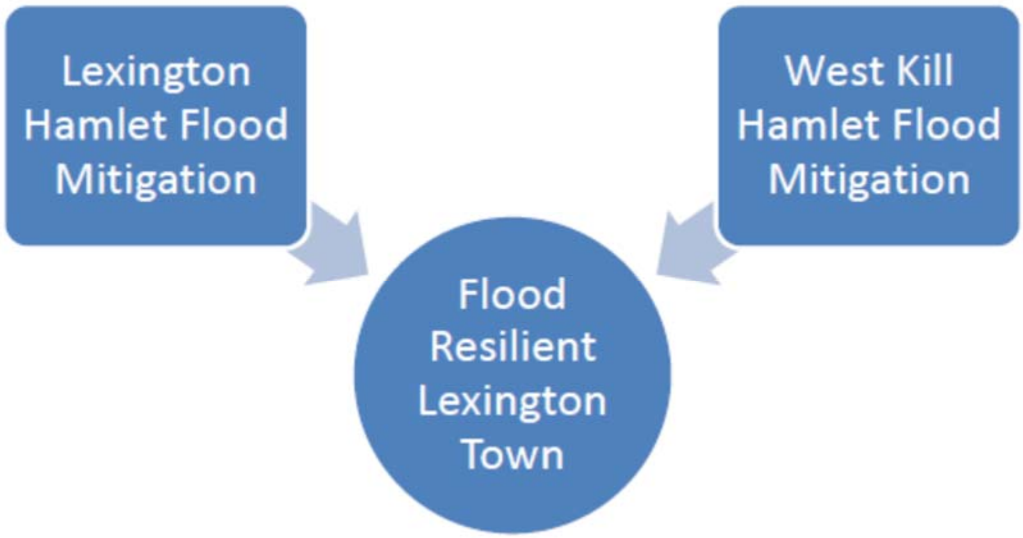
Figure 6-2
Implementation Framework for Lexington Hamlet



West Kill Hamlet – Implementation in West Kill is more straightforward than implementation in Lexington Hamlet. In West Kill, all of the options are unrelated to one another and will result in lower risks only at the buildings being acquired or elevated. Therefore, individual projects may proceed in any sequence as property owners come forward and express interest. Likewise, stream stabilization upstream of the Route 42 bridge would be pursued for the benefit of the bridge and does not depend on other projects for its implementation.

Figure 6-3 depicts the relationship between all of the mitigation projects in the town of Lexington. If projects are completed in both hamlets, the town will be more resilient when the next flood occurs.

Figure 6-3
Implementation Framework for Town of Lexington



6.4 Descriptions of Funding Sources

Several funding sources may be available to the Town of Lexington and Greene County and its departments for the implementation of recommendations of this plan.

Local Flood Analysis (LFA) and Stream Management Program

The LFA program that funded this study and report is likely to be the primary funding vehicle for some of the projects described in this report. As described in the LFA rules, "Stream Management Programs in the NYC water supply watersheds and the Catskill Watershed Corporation are supporting the analysis of flood conditions and the identification of hazard mitigation projects. The process consists of two steps: 1) an engineering analysis of flood conditions and identification of potential flood mitigation projects articulated in a plan and 2) project design and implementation. The engineering analysis and plan are termed "Local Flood Analysis." These program rules (Section C) define the process for municipalities to apply for funding to complete a Local Flood Analysis (LFA). These program rules (Section D) also define the process for municipalities to seek funding from the Stream Management Program to implement projects that involve streams, floodplains and adjacent infrastructure to reduce flood hazards."

NYCDEP Buyout Program

The buyout program is used to acquire individual properties in the water supply watersheds and convert them to open space in order to reduce future flood damages. Although large-scale buyouts in Lexington are not supported by this LFA at the present time, several properties have been identified in this LFA as targeted for acquisition. The buyout program could potentially be used for some of these acquisitions.

Catskills Watershed Corporation (CWC) Flood Hazard Mitigation Implementation Program

The CWC is a local development corporation established to protect the water resources of the New York City watershed west of the Hudson River (WOH); to preserve and strengthen communities located in the region; and to increase awareness and understanding of the importance of the NYC water system. CWC administers a number of programs under this mission such as:

- Septic Repair and Maintenance – Funds residential septic system repairs, replacements, and maintenance
- Stormwater Planning and Control – Funds planning, assessment, design, and implementation of stormwater and erosion controls for existing conditions as well as stormwater requirements for new construction
- Education – Provides grants to schools and organizations
- Community Wastewater Management – Funds a program to evaluate and build community-specific wastewater solutions, which may include septic maintenance districts, community septic systems, or wastewater treatment plants
- Local Technical Assistance Program – Provides grants to communities conducting watershed protection and land use planning initiatives

The Flood Hazard Mitigation Implementation Program was unveiled in 2015. This program specifically allows funding of projects identified in LFA reports subject to various restrictions that are listed in the CWC Flood Hazard Mitigation Implementation Program rules (revised through April 5, 2016). Many of the project components described in this report are believed eligible for funding under this program.

Emergency Watershed Protection Program (EWP)

Through the EWP program, the U.S. Department of Agriculture's NRCS can help communities address watershed impairments that pose imminent threats to lives and property. Most EWP work is for the protection of threatened infrastructure from continued stream erosion. NRCS may pay up to 75 percent of the construction costs of emergency measures. The remaining costs must come from local sources and can be made in cash or in-kind services. EWP projects must reduce threats to lives and property; be economically, environmentally, and socially defensible; be designed and implemented according to sound technical standards; and conserve natural resources.

The West Kill Hamlet stream bank stabilization described in this LFA report may be an appropriate match for the NRCS EWP program.

FEMA Pre-Disaster Mitigation (PDM) Program

The Pre-Disaster Mitigation Program was authorized by Part 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 U.S.C. 5133. The PDM program provides funds to states, territories, tribal governments, communities, and universities for hazard mitigation planning and implementation of mitigation projects prior to disasters, providing an opportunity to reduce the nation's disaster losses through pre-disaster mitigation planning and the implementation of feasible, effective, and cost-efficient mitigation measures. Funding of pre-disaster plans and projects is meant to reduce overall risks to populations and facilities.

The PDM program is subject to the availability of appropriation funding as well as any program-specific directive or restriction made with respect to such funds. In recent years, funds were extremely limited, and FEMA provides strict constraints to the states on how many projects could be submitted for consideration.

FEMA Hazard Mitigation Grant Program (HMGP)

The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. A key purpose of the HMGP is to ensure that any opportunities to take critical mitigation measures to protect life and property from future disasters are not "lost" during the recovery and reconstruction process following a disaster.

The HMGP is one of the FEMA programs with the greatest potential fit to potential projects in this LFA. However, it is available only in the months subsequent to a federal disaster declaration in the State of New York. Because the state administers the HMGP directly, application cycles will need to be closely monitored after disasters are declared in New York.

FEMA Flood Mitigation Assistance (FMA) Program

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the NFIP. FEMA provides FMA funds to assist states and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, homes, and other structures insurable under the NFIP. The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities.

The Biggert-Waters Flood Insurance Reform Act of 2012 eliminated the Repetitive Flood Claims (RFC) and Severe Repetitive Loss (SRL) programs and made the following significant changes to the FMA program:

- The definitions of repetitive loss and SRL properties have been modified.
- Cost-share requirements have changed to allow more federal funds for properties with RFCs and SRL properties.
- There is no longer a limit on in-kind contributions for the nonfederal cost share.

One limitation of the FMA program is that it is used to provide mitigation for *structures* that are insured or located in SFHAs. Therefore, the individual property mitigation options described in this LFA are best suited for FMA funds. Like PDM, FMA programs are subject to the availability of appropriation funding as well as any program-specific directive or restriction made with respect to such funds.

NYS Department of State

The Department of State may be able to fund some of the projects described in this report. In order to be eligible, a project should link water quality improvement to economic benefits.

6.5 Potential Funding Sources for Mitigation Projects

Tables 6-1 (Lexington Hamlet) and 6-2 (West Kill Hamlet) list the potential funding sources for components of the town's mitigation projects. Note that in all cases federal funds cannot be duplicated for any particular project.

TABLE 6-1
Potential Funding Sources for Components of Mitigation Projects in Lexington Hamlet

Mitigation Projects		Federal	State	Other
Flood Mitigation in Center of Lexington Hamlet	Acquire home on south side of Route 13A.	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Acquire Lexington Hotel.	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Lower the sewer pipe between Route 13A and Schoharie Creek.	None	NYSDOS	CWC
	Create floodplain bench.	None	NYSDOS	GCSWCD SMP, CWC
	Replace Route 42 bridge.	None	NYSDOT	CWC

Mitigation Projects		Federal	State	Other
Flood Mitigation at Route 23A and Banks Road	Elevate homes.	FEMA	NYSDOS	CWC
	Conveyance and backwater reduction projects	None	NYSDOS	GCSWCD SMP, CWC
Building-Specific Mitigation Projects	Remove building in the floodway: • Parcel 127.04-3-6 (Route 42, address unknown)	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Elevate buildings in FEMA SFHA: • 3589 Route 42 • 3609 Route 42 • 3617 Route 42 • Parcel 127.04-3-9 (east of town hall, address unknown)	FEMA	NYSDOS	CWC

Notes: FEMA = Federal Emergency Management Agency
NYSDOS = New York State Department of State
NYCDEP = New York City Department of Environmental Protection
CWC = Catskill Watershed Corporation
GCSWCD SMP = Greene County Soil & Water Conservation District Stream Management Program

TABLE 6-2
Potential Funding Sources for Mitigation Projects in West Kill Hamlet

Mitigation Projects	Federal	State	Other
Remove buildings in the floodway: • 2493 Route 42	FEMA	None	CWC
Elevate buildings in FEMA SFHA: • 2486 Route 42* • 2516 Route 42	FEMA	None	CWC
Elevate buildings in 500-yr flood zone: • 173 Spruceton Road • 161 Spruceton Road • 141 Spruceton Road (Community Hall) • 2521 Route 42	FEMA	None	CWC
Riverbank stabilization upstream of Route 42 bridge	FEMA, NRCS	None	GCSWCD SMP, CWC

*This house is mapped in three risk zones (no risk, SFHA, and floodway) but is assumed to be primarily in the SFHA; the floodway boundary should be delineated more accurately.

Notes: FEMA SFHA = Federal Emergency Management Agency Special Flood Hazard Area
NRCS = Natural Resources Conservation Service
CWC = Catskill Watershed Corporation
GCSWCD SMP = Green County Soil & Water Conservation District Stream Management Program

As this LFA plan is implemented, the Lexington Flood Commission and the Town of Lexington will need to work closely with potential funders to ensure that the best combinations of funds are secured for the floodplain mitigation projects and for the property-specific mitigation such as floodproofing, elevations, and relocations. Because FEMA's mitigation funds are limited by Congress (PDM and FMA) or dependent on disaster declarations (HMGP), the state hazard mitigation officer should be kept apprised of the town's efforts for mitigating flooding and flood damage.

7.0 REFERENCES

Federal Emergency Management Agency, 2008. Flood Insurance Study, Greene County, New York (All Jurisdictions). FEMA Flood Insurance Study Number 36039CV001A. Effective May 16, 2008.

Federal Emergency Management Agency, 2009. BCA Reference Guide.

Federal Emergency Management Agency, 2011. Supplement to the Benefit-Cost Analysis Reference Guide.

Brierley, Gary J. and Kristie A. Fryirs, 2005. Geomorphology and River Management. Blackwell Publishing.

Greene County Soil & Water Conservation District, 2007. Schoharie Creek Management Plan.

Greene County Soil & Water Conservation District, 2005. West Kill Stream Management Plan.

Tetra-Tech, 2009. Hazard Mitigation Plan for Greene County, New York.

Greene County Hazard Mitigation Plan, Town of Lexington Annex

USGS, *StreamStats*, 2014

2884-03-5-m1016-rpt

APPENDIX A

Photo Log

West Kill Hamlet

West Kill viewed from Route 6 bridge

Route 23A, Lexington Hamlet

Lexington Town Hall and Fire House

Route 42 bridge over Schoharie Creek, Lexington Hamlet

West Kill viewed from Route 42 “Basil” bridge

Schoharie Creek downstream of Route 42 bridge

Schoharie Creek along Lexington Hotel

APPENDIX B

Incorporating Water Quality Benefits into Benefit-Cost Analysis

Incorporating Water Quality Benefits into Benefit Cost Analysis (BCA)

A discussion of approaches that can be used by the Lexington Flood Commission

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Standard FEMA BCA relies on the reduction of flood inundation to calculate benefits (in units of dollars) from avoided losses and damages. Over the years, FEMA's BCA program has been modified to include other factors that can be quantified and summed with flood inundation benefits, such as open space and riparian benefits, mental health, and volunteer costs. As of 2016, calculation of water quality benefits has not been added to the BCA program. Nevertheless, flooding is known to cause impaired water quality. Therefore, reduction of flooding is believed to proportionally reduce water quality impairment by reducing the area of land and buildings exposed to floodwaters and by reducing the depth and velocity of floodwaters that mobilize pollutants. Two approaches to including water quality benefits are discussed in this memorandum.

Approach Number 1

When the Local Flood Hazard Mitigation Analysis (LFHMA) [now LFA] program was being discussed in 2012, discussions about incorporating water quality benefits focused on developing appropriate "scores" that would correspond to "multipliers" that would then be applied to the benefit cost ratio (BCR) when proposed flood mitigation projects would reduce water quality impairment if implemented. Discussions centered on a set of scores for "chemical release prevention" ranging from zero (no water quality benefits) to 2.0 ("will protect at least one but less than six contaminant sources") to 4.0 ("will protect more than six potential contaminant sources"). Separate scores were developed for sediment transport from properties (as opposed to sediment transport from stream banks) and wetland preservation.

During these early discussions, stakeholders understood that low BCRs such as 0.3 would have a low likelihood of increasing above 1.0 when multipliers corresponding to moderate benefit were applied (0.3 x 2.0 = 0.6) but would have a higher likelihood of increasing above 1.0 when multipliers corresponding to significant benefit were applied (0.3 x 4 = 1.2). For this reason, the multipliers were set as follows:

- If total score is less than 4, multiplier = 1.0
- If total score is between 4 and 7, multiplier = 1.1
- If total score is greater than 7, multiplier = 1.2

Although this approach gained modest traction, it was not incorporated into the final LFHMA rules.

Since 2012, the additional factors incorporated into the BCA tool (open space and riparian benefits, mental health, and volunteer costs) were programmed to become available only when flood inundation benefits alone were sufficient to generate a BCR of 0.75 or greater[1]. In other words, these benefits can help make a "nearly cost effective" project into a cost effective project. This has set a reasonable precedent and a benchmark for considering water quality benefits in the BCA completed for LFAs.

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[1] According to FEMA (2013), "green open space and riparian area benefits can now be included in the project benefit cost ratio (BCR) once the project BCR reaches 0.75 or greater."

The rollout of the LFA program has reflected a wide range in the number of buildings contributing to BCA for a particular community, from approximately 30 (for Lexington Hamlet) to more than 180 (for the Village of Walton). Some of the properties are residential and therefore would be expected to contribute to water quality impairment from heating fuels, vehicles, and sanitary wastewater. Other properties are nonresidential and would be expected to contribute to water quality impairment from heating fuels, vehicles, sanitary wastewater, and pollutants that are associated with the land use such as gasoline, oils, chemicals, food products, fertilizers, herbicides, pesticides, etc. In light of the differences from community to community, the approach discussed in 2012 (a set of scores for chemical release prevention ranging from zero to 2.0 [will protect at least one but less than six contaminant sources] to 4.0 [will protect more than six potential contaminant sources]) seems somewhat arbitrary. A community like Walton will easily have more than six potential contaminant sources whereas a community like Lexington Hamlet may not.

For this reason, it may be more appropriate to apply multipliers to the *individual* benefits associated with each property rather than apply multipliers to the sum of all benefits associated with a mitigation project. A new scoring system could be developed, with new multipliers associated with each sum of scores. Scores would be higher for commercial and industrial properties than they would be for residential properties, and the multipliers would therefore be greater for commercial and industrial properties than they would be for residential properties.

Approach Number 2

In a review of the literature, direct studies that provide an impact value to reduced water quality are limited. Turbidity and sediment loading are the issues most frequently studied in relation to water quality benefits in watersheds. Most studies use indirect methods, such as impact to tourism or "willingness to pay" surveys to compute the perceived value of water quality.

Three studies were reviewed to estimate a dollar figure ($) of water quality benefits per acre per year that could be utilized within the context of a BCA for LFAs.

- A study conducted by the State of New Hampshire focused on the potential impact to tourism from a perceived water quality reduction. The study predicted that the statewide impact would be $69 million per year, equivalent to a water quality value of $11.5/acre/year.

- A USDA study of New York State found that the societal benefits of reducing erosion are greater than $9/ton/year for all counties in the state. In other words, a one-ton reduction in soil erosion can increase societal benefits by $9/year. In an effort to apply this value to the West-of-Hudson region, the Upper Esopus Creek Management Plan was consulted. Using the long-term average sediment yield from Appendix III and applying the figure on an area basis, the societal benefits of reducing erosion in that watershed were $10.8/acre/year, reasonably close to the New Hampshire figure.

- Several "willingness to pay" studies were also reviewed. One of the studies summarized a significant amount of previous work nationwide. This study found an overall "willingness to pay" for improved water quality to range from $90 to $112 per person per year. In an effort to relate this value to the West-of-Hudson region, this data was applied to the Upper Esopus Creek Management Plan, resulting in a "willingness to pay" figure for water quality of $10.8/acre/year, in line with the USDA study.

The average of these three methods is approximately $11/acre/year. The range of figures is narrow and although this may be somewhat coincidental, it suggests that the average may be defensible in the West-of-Hudson region.

If per-acre figures were to be used to quantify water quality benefits, the calculation could be conducted on a parcel-by-parcel basis. As an alternative, it could be applied to the entire flooded area. Two additional choices are available: the per-acre figure could be allowed as a benefit on a "pass/fail" basis (either the land floods or it will not flood because a mitigation project has been completed in the future); or the per-acre figure could be used to generate a "depth-impact" function similar to the depth-damage curves currently used by the BCA. These depth-impact functions would then be combined with reductions in flood elevations to generate water quality benefits that vary from a minimum to a maximum according to depth of flooding avoided or reduced. Borrowing from approach #1 above, multipliers could still be applied to these calculations based on the type of parcel. For example, an industrial parcel should have the potential to have a greater impact on water quality than a residential parcel.

Ultimately, approach #2 may not generate sufficient benefits for use in LFAs. This is likely because per-acre benefits are typically estimated from watershed-scale studies or greater, including the three described above. In contrast to a watershed, the SFHA within any given watershed is only a fraction of the total area. If $11/acre/year were multiplied by the total acreage of the Lexington Area B focus area in the SFHA (perhaps 60 acres), the result is only $660 per year. Projected over 50 years (the projection used by the BCA program for flood mitigation projects) without considering flood recurrence intervals, the benefit would be only $33,000. This is a nominal figure when compared to the benefits typically generated by the BCA program from flood reductions at numerous buildings.

Summary

Approach #1 appears to offer the most significant potential for quantifying water quality benefits, and it is most consistent with the approach discussed when the LFHMA rules were initially developed. Two recommendations are offered if this approach is used to generate water quality benefits:

- The BCR must be 0.75 or greater to allow water quality benefits.
- Multipliers should be applied to the individual benefits generated for each property, and should differ for residential vs. nonresidential properties.