Local Flood Analysis

Hamlets of Roxbury and Grand Gorge
Town of Roxbury, Delaware County, New York
February 2020

Prepared for:
Delaware County Soil and
Water Conservation District
44 West Street, Suite 1
Walton, New York 13865

MMI #5197-15-06

Prepared by:
MILONE & MACBROOM, INC.
231 Main Street, Suite 102
New Paltz, New York 12561
(845) 633-8153
www.mminc.com

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

ABBREVIATIONS/ACRONYMS

BCA	Benefit-Cost Analysis
BFE	Base Flood Elevation
CAP	Community Assistance Program
CAV	Community Assistance Visit
CFS	Cubic Feet per Second
CRRA	Community Risk and Resiliency Act
CRS	Community Rating System
CWC	Catskill Watershed Corporation
DCSWCD	Delaware County Soil and Water Conservation District
DEM	Digital Elevation Model
DPW	Department of Public Works
EBDR	East Branch Delaware River
EWP	Emergency Watershed Protection
FAC	Flood Advisory Committee
FBO	Flood Buyout
FEMA	Federal Emergency Management Agency
FHM	Flood Hazard Mitigation (funding category in SMIP)
FHMIP	Flood Hazard Mitigation Implementation Program
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FPMS	Floodplain Management Services Program
GCSWCD	Greene County Soil and Water Conservation District
GIS	Geographic Information System
HDPE	High Density Polyethylene
HEC-HMS	*Hydrologic Engineering Center – Hydrologic Modeling System*
HEC-RAS	*Hydrologic Engineering Center – River Analysis System*
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HSG	Hydrologic Soil Group
LFA	Local Flood Analysis
LiDAR	Light Detection and Ranging
MMI	Milone & MacBroom, Inc.
MWRR	Municipal Waste Reduction and Recycling
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act
NRCC	Northeast Regional Climate Center
NRCS	Natural Resources Conservation Service
NWIS	National Water Information System
NYC	New York City
NYCDEP	New York City Department of Environmental Protection
NYCFFBO	New York City Funded Flood Buyout
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
PDM	Pre-Disaster Mitigation
RFC	Repetitive Flood Claims
SCMP	Stream Corridor Management Plan

SFHA	Special Flood Hazard Area
SMIP	Stream Management Implementation Program
SMP	Stream Management Plan
SRL	Severe Repetitive Loss
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WI/PWL	Waterbody Inventory/Priority Waterbodies List

EXECUTIVE SUMMARY

The Delaware County Soil and Water Conservation District has retained Milone & MacBroom, Inc. to complete a Local Flood Analysis in the hamlets of Roxbury and Grand Gorge. A Local Flood Analysis is an engineering feasibility analysis that seeks to develop a range of hazard mitigation alternatives. Its primary purpose is to identify flood hazards and mitigation options for the community to implement. In the long term, these mitigation options are designed to reduce flooding and facilitate recovery from flood events. The flood analysis focuses on the East Branch of the Delaware River and several tributaries in Roxbury, and on the Bear Kill in Grand Gorge.

The Catskill Mountains are subject to large storm events that are often unevenly distributed across watersheds. As a result, local flash floods can occur in one basin while an adjacent basin receives little rainfall. In addition to local flash floods, larger storm events can cause widespread flooding. Major floods have occurred periodically over the last century with at least 11 major floods occurring since 1933. Floods can take place any time of the year but are commonly divided into those occurring in winter and spring and those occurring in summer and fall. Floods that take place in summer and fall are typically due to extreme rainfall events caused by hurricanes and tropical storms. Floods in winter and spring are associated with rain on snow events and spring snowmelt.

A public meeting was convened at the Roxbury Town Hall at the beginning of the Local Flood Analysis process. Attendees were provided with an overview of the project, the Local Flood Analysis process, and hydraulic modeling techniques. Large-format maps were provided, and attendees were asked to point out locations of flooding and flood damages during both Tropical Storm Irene and previous flood events. Information was collected on flood damages and potential flood mitigation alternatives. This information was used throughout the Local Flood Analysis process to verify flood damages, pinpoint problem areas, and develop flood mitigation alternatives.

Public remarks underline Vega Mountain Stream as a frequent source of flooding in the hamlet of Roxbury while flooding along the East Branch Delaware River has been far less frequent and less damaging. Analysis of data collected by the United States Geological Survey stream gauge located on the East Branch Delaware River in Roxbury signifies that, in the available period of record (2001 to current), annual peak flows recorded at the gauge have not exceeded the estimated 10-year peak discharge. Similarly, in the hamlet of Grand Gorge, comments received during public meetings indicate that flooding along the Bear Kill mainstem has been infrequent. The stream gauge on the Bear Kill near Schoharie Reservoir has recorded peak flows that have only marginally exceeded the estimated 10-year storm event in the years that the gauge has been operational (1999 to current).

Hydraulic assessment was used to evaluate historical and predicted water surface elevations, to identify flood-prone areas, and to help develop mitigation strategies to minimize future flood damages and protect water quality. Specific locations were identified within the project area as being prone to flooding. Alternatives were developed and assessed at each area where flooding is known to have caused damage to infrastructure and properties.

Five bridges and three culverts were evaluated using hydraulic modeling. In the hamlet of Roxbury, four bridges spanning the East Branch of the Delaware River were evaluated for hydraulic adequacy including the structures along North Montgomery Road, NYS Route 30, behind Roxbury Central School, and Bridge Street (County Route 41). In Grand Gorge, the NYS Route 30 bridge over the Bear Kill was assessed. Bridges that were found to be undersized and acting as hydraulic constrictions were identified.

The three assessed culverts are located along Vega Mountain Stream, a tributary to the East Branch of the Delaware River that runs adjacent to, and crosses under, Vega Mountain Road in Roxbury. All three culverts were found to be substantially undersized, acting as severe hydraulic constrictions and overtopping during large storm events. Drainage from Vega Mountain is a leading source of flooding in the hamlet of Roxbury. There have been several instances when the large volume of water coming from the tributary cannot be transported by the stream channel and the culvert at Vega Mountain Road. Consequently, floodwaters travel directly down Vega Mountain Road, creating a hazardous situation and damaging homes and business in the area. Hydraulic modeling was used to evaluate the culverts, and adequately sized recommended replacement structures are summarized in TABLE ES-1. Note that the NYS Route 30 culvert assumes that the existing sections of stream that are currently underground be reverted to an open-air watercourse, or daylighted. Recommendations are prioritized on factors including the severity of flooding caused by the structure and the existing structural condition of the culverts. When any of these culverts is scheduled for replacement, it is recommended that a full hydraulic assessment be conducted to ensure that the new structure meets New York State Department of Transportation hydraulic design standards and New York State Department of Environmental Conservation stream crossing guidelines.

TABLE ES-1
Recommendations for Assessed Culverts in Roxbury Local Flood Analysis Area

Priority*	Location	Existing		Recommended		Notes
		Inlet Description	Inlet Capacity	Description	Capacity	
1	Underground storm drainage system under NYS Route 30	4-foot-diameter, corrugated metal pipe in moderate condition	1-year flood	16' x 5' concrete box w/wingwalls	50-year flood	Requires daylighting sections of channel on both sides of NYS Route 30; install new culvert under Route 30 roadway.
2	Vega Mountain Road	4-foot-diameter smooth metal pipe in moderate condition	1-year flood	16' x 4' concrete box w/wingwalls	50-year flood	Requires enlarging sections of channel upstream and downstream of Vega Mountain Road
3	Vega Mountain Road near intersection with Johnson Road	4-foot-diameter smooth metal pipe in good condition	5-year flood	12' x 5' concrete box w/wingwalls	50-year flood	Structure was replaced during last severe storm. History of failure; poor hydraulics

**Priority is listed based on recommended project implementation sequence for the structures on Vega Mountain Road.*

Flooding of bridges, culverts, and roadways during storm events has been reported at several locations in Roxbury and Grand Gorge. It is recommended that risks associated with the flooding of bridges and roadways be reduced by temporarily closing flood-prone roads during flooding events. This requires effective signage, road closure barriers, and consideration of alternative routes.

A report was received from a property owner along the East Branch of the Delaware River just upstream of Bridge Street, who reported that flooding of outbuildings had worsened on their property following the installation of a sewer system that entailed excavation, grading, and installation of a manhole and resulted in the creation of a hillock on the property. It is recommended that the town investigate and determine whether regrading could be undertaken to correct this issue.

Critical facilities are public facilities that if destroyed or damaged would impair the health and/or safety of the community. In either community, there were no facilities described to have experienced flooding during past flood events. Nevertheless, it is advisable that critical facilities located within the Special Flood Hazard Area consider relocating outside the designated flood zone in order to avoid any likelihood of future flood disaster losses.

For homes and properties located within the Special Flood Hazard Area, it is recommended that the town work to relocate the most flood-vulnerable properties where there is owner interest and programmatic funding available through flood buyout, relocation, and structure elevation programs.

Some homes in the Special Flood Hazard Area are rarely flooded. Residents and businesses may benefit from minor individual property improvements. Providing landowners with information regarding individual property protection is recommended. In areas where properties are vulnerable to flooding, improvements of individual properties and structures may be appropriate. Potential measures for property protection include the following:

- Elevation of the structure
- Dry floodproofing of the structure to keep floodwaters from entering
- Wet floodproofing of the structure to allow floodwaters to pass through the lower area of the structure unimpeded
- Performing other home improvements, such as elevating utilities, to mitigate damage from flooding
- Encouraging property owners to purchase flood insurance under the National Flood Insurance Program (NFIP) and to make claims when damage occurs

The Town of Roxbury adopted a Local Flood Damage Prevention Law as local law No. 1 in 2016. It is recommended that town government staff seek training regarding the content and implementation of the law. This will allow town officials to successfully disseminate information regarding the law to the public and to implement the law accurately.

It is recommended that sources of man-made pollution be reduced or eliminated through the relocation or securing of fuel oil and propane tanks, as well as any other stored chemicals. It is

recommended that the town gather and file flood-related lost revenue information as provided by businesses and that the town record and compile municipal, county, and state costs related to cleanup and recovery. During and after future floods, it is recommended that high water marks be recorded if it is safe to do so.

A number of potential funding sources are identified in Section 7.0 of this report. As the recommendations of this Local Flood Analysis are implemented, the Town of Roxbury should work closely with potential funders to ensure that the best combinations of funds are secured for the recommended flood mitigation alternatives. It would be advantageous for the town to identify combinations of funding sources in order to reduce its own requirement to provide matching funds.

1.0 INTRODUCTION

1.1 Project Background

Milone & MacBroom, Inc. (MMI) has been retained to conduct a Local Flood Analysis (LFA) in the hamlets of Roxbury and Grand Gorge. The LFA has been undertaken with funding provided by the New York City Department of Environmental Protection (NYCDEP), administered through the Delaware County Soil and Water Conservation District (DCSWCD).

The Catskill Mountains are subject to large storm events that are often unevenly distributed across watersheds. As a result, local flash floods can occur in one basin while an adjacent basin receives little rainfall. In addition to local flash floods, larger storm events can cause widespread flooding.

This LFA builds upon existing hydraulic modeling to evaluate a variety of flooding issues in the hamlets of Roxbury and Grand Gorge and assess potential mitigation measures aimed at reducing flood inundation. The LFA is a program specific to the New York City water supply watersheds that was initiated following Tropical Storm Irene to help communities identify long-term, cost-effective projects to mitigate flood hazards.

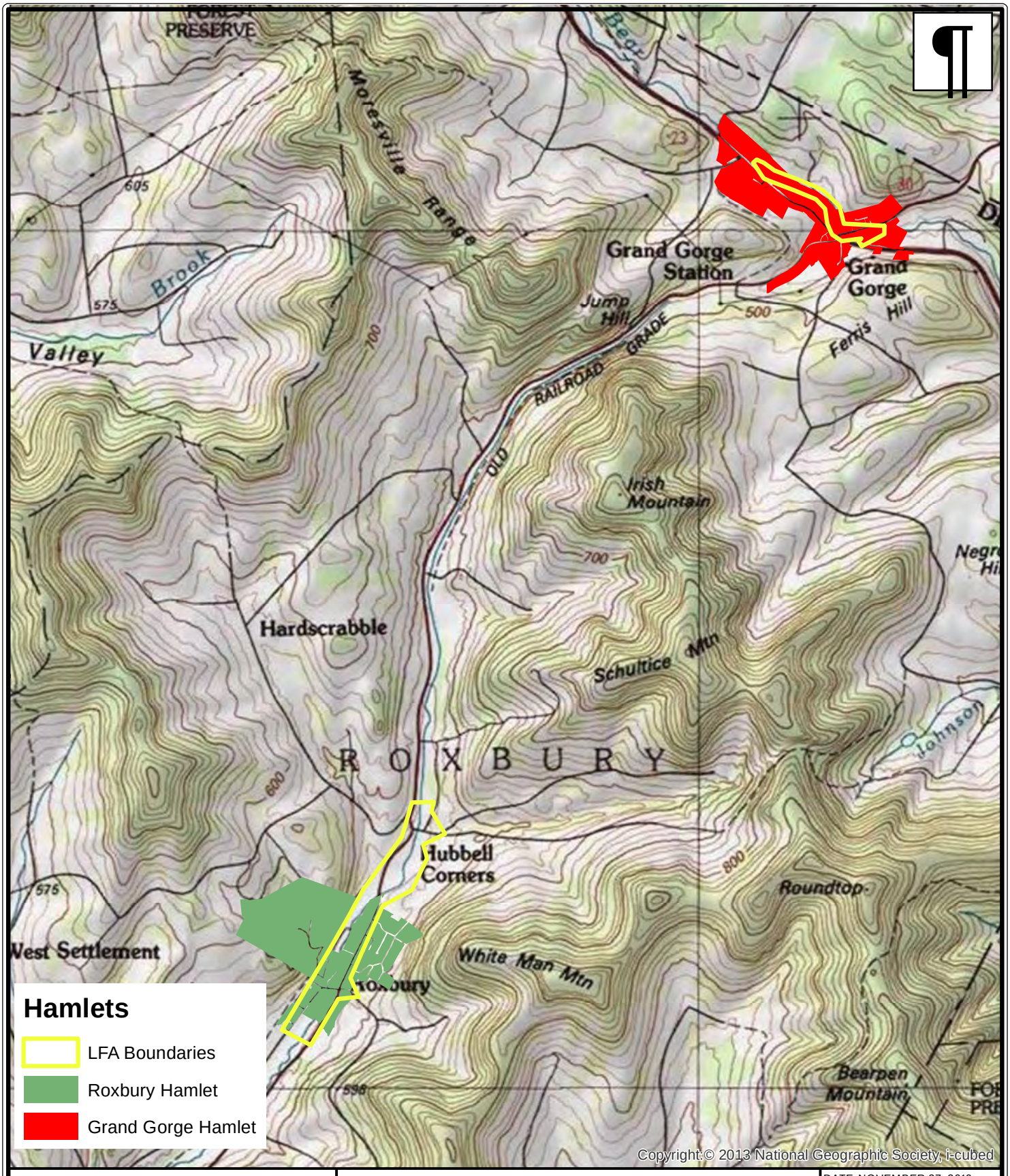
Project recommendations generated through an approved LFA may be eligible for Flood Hazard Mitigation funding available through the Stream Management Implementation Program (SMIP) administered by DCSWCD, the Catskill Watershed Corporation's (CWC) Flood Hazard Mitigation Implementation Program (FHMIP), or the New York City (NYC) funded Flood Buyout Program (FBO). A more detailed list of potential funding sources is included in this LFA report.

1.2 Study Area

The subject LFA focuses on flooding mitigation and infrastructure improvements within the hamlets of Roxbury and Grand Gorge (Figure 1-1) although flooding hazards may exist elsewhere in the town. The following high-priority areas are the focus of this LFA:

- The East Branch of the Delaware River (EBDR) as it flows through the hamlet of Roxbury, including the adjacent floodplains throughout the hamlet limits
- The following bridges spanning the EBDR, listed from upstream to downstream:
    - the North Montgomery Hollow Road bridge
    - the New York State (NYS) Route 30 bridge
    - the bridge behind Roxbury school that provides access to the baseball/softball fields and tennis courts
    - the Bridge Street (County Route 41) bridge
- Pleasant Valley Brook as it flows adjacent to Robbins Road downstream to its confluence with the EBDR north of Kirkside Park

MXD: Q:\Projects\5197-15 Roxbury Grand Gorge LFA\GIS\MXD\HamletLocations.mxd



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

LFA STUDY AREAS

Roxbury & Grand Gorge
Local Flood Analysis

Town of Roxbury
Delaware County, New York

SOURCE: USA Topographic Maps

DATE: NOVEMBER 27, 2019
SCALE: 1"=5000'
PROJ. NO.: 5197-15

Figure 1-1

- The unnamed tributary of the EBDR that flows adjacent to Vega Mountain Road, including the following culverts listed from upstream to downstream:
    - the culvert crossing under Vega Mountain Road at its intersection with Ken Johnson Road
    - the culvert crossing under Vega Mountain Road near Roxbury Arts Center
    - the NYS Route 30 culvert
- The Bear Kill through the hamlet of Grand Gorge, including the adjacent floodplains throughout the hamlet limits
- The following bridge spanning the Bear Kill:
    - the NYS Route 30 bridge

1.3 Community Involvement

The LFA was undertaken in close consultation with the Town of Roxbury Flood Advisory Committee (FAC). The FAC is comprised of individuals with technical and nontechnical backgrounds and is meant to represent various interests and stakeholders at town and county levels as well as the DCSWCD and NYCDEP. The FAC met regularly over the course of the LFA process to review results and provide input on flood mitigation alternatives. Meeting notes from the FAC meetings are included in Appendix B. FAC members include representatives from the following organizations and backgrounds:

- Roxbury Town Board
- DCSWCD
- NYCDEP
- CWC
- MMI

The LFA process also included two public meetings. The first public meeting took place at the start of the LFA in order to inform the public about the LFA process and gather input about flood events and flood damages in Roxbury and Grand Gorge. The second public meeting was held at the end of the LFA in order to share the findings of the analysis and gather final input and feedback.

Table 1-1 summarizes the FAC and public meetings that took place during the LFA process.

TABLE 1-1
FAC Meeting Schedule

Date	Type of Meeting	Topic
April 2, 2019	FAC	Introduction to and overview of LFA process; gathering of flood information from FAC members
May 7, 2019	Public	Introduction to and overview of LFA process; gathering of flood information from members of the public
June 18, 2019	FAC	Presentation of preliminary hydraulic modeling results; solicitation of feedback regarding proposed alternatives
July 23, 2019	FAC	Presentation of refined hydraulic modeling results; scheduled a date for site walk of areas of interest, open to all FAC members to attend
August 8, 2019	Site Walk	Toured Grand Gorge and Roxbury with representatives from CWC, DEP, DCSWCD, and FAC
September 17, 2019	FAC	Presentation of final hydraulic modeling results; final recommendations and feedback from members regarding draft report
November 19, 2019	Public	Summary recap of the LFA process and findings; present recommendations to members of the public and distribute draft report

1.4 Nomenclature

The Federal Emergency Management Agency (FEMA) is an agency of the United States Department of Homeland Security. In order to provide a common standard, FEMA's NFIP has adopted a baseline probability called the base flood. The base flood has a 1 percent (one in 100) chance 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 recurrence 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 (0.2 percent annual chance flood). The Special Flood Hazard Area (SFHA) is the area inundated by flooding during the 100-year flood event. Within the project area of this LFA, FEMA has developed Flood Insurance Rate Maps (FIRMs) that indicate the location of the SFHA along the EBDR. No FIRMs have been developed for the Vega Mountain Stream or Pleasant Valley Brook.

It should be noted that over the time period of a standard 30-year property mortgage a property located within the SFHA will have a 26 percent chance of experiencing a 100-year flood event. Structures falling within the SFHA may be at an even greater risk of flooding because if a house is low enough it may be subject to flooding during the 25-year or 10-year flood events. During the period of a 30-year mortgage, the chance of being hit by a 25-year flood event is 71 percent, and the chance of being hit by a 10-year flood event is 96 percent, which is a near certainty.

The East Branch of the Delaware River is abbreviated throughout this report as the EBDR. The name of the tributary to the EBDR that runs adjacent to Vega Mountain Road may be a source of confusion. Section 9.22 of the flood hazard mitigation plan for Delaware County, dated March 2013, identifies this tributary as Bonnie Brook; however, the drainage from Vega Mountain was often referred to as Vega Mountain Stream during FAC meetings. This report will denote the watercourse as Vega Mountain Stream as it is known within the Roxbury community.

The New York State Department of Transportation (NYSDOT) classifies stream crossings as bridges or culverts based on their span length alone rather than their hydraulic design or construction. Any structure with a span greater than 20 feet is considered a bridge; spans shorter than 20 feet are considered culverts. For example, a 25-foot-span box culvert would be classified as a bridge, and a 15-foot-span bridge would be considered a culvert. NYSDOT enforces substantially different hydraulic design standards for bridges and culverts, which may have considerable implications in project cost.

In this report, all references to right bank and left bank refer to "river right" and "river left," meaning the orientation assumes that the reader is standing in the river looking downstream.

2.0 WATERSHED INFORMATION

2.1 Watercourse and Watershed Characteristics

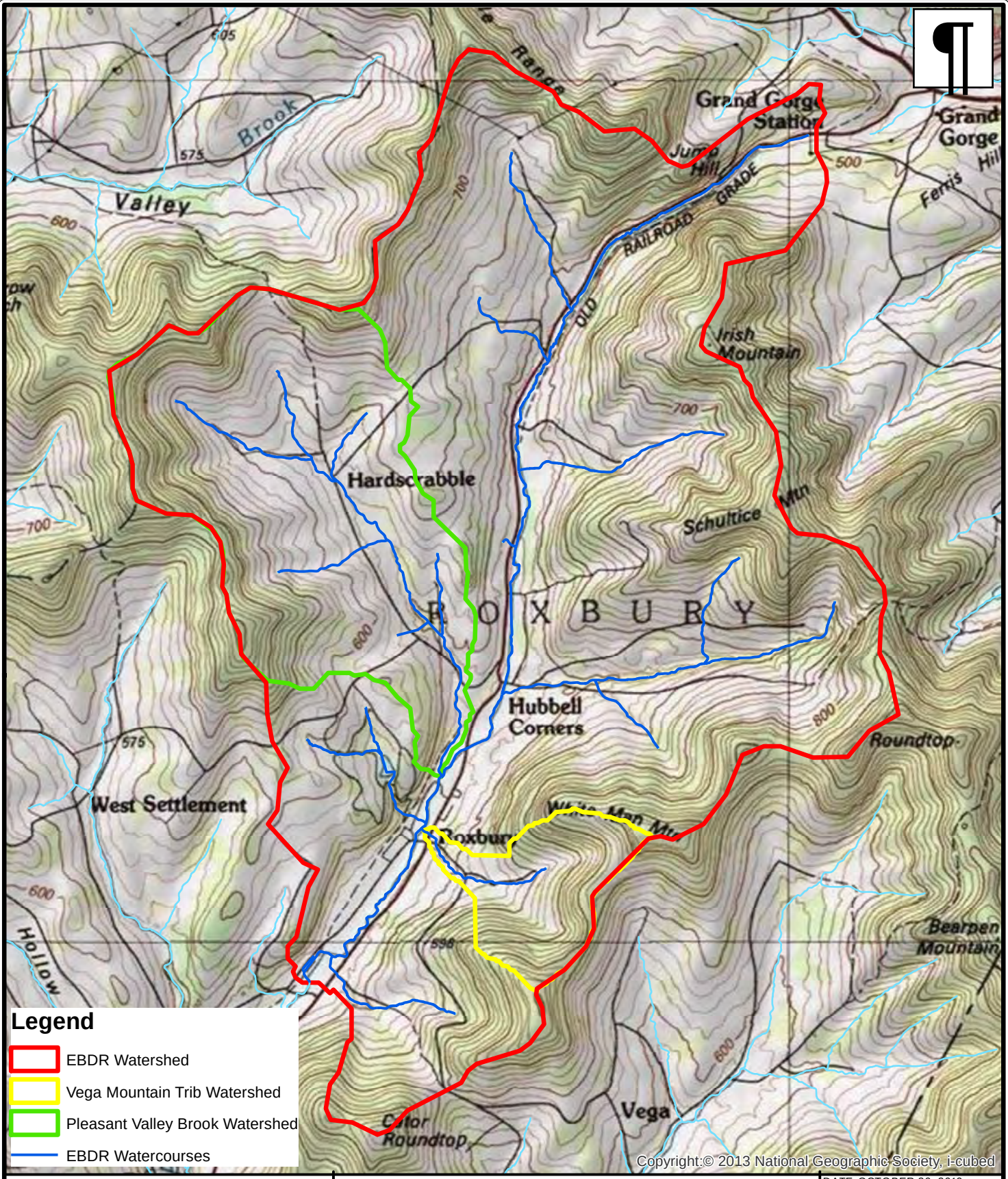
Hamlet of Roxbury

The main watercourse draining the hamlet of Roxbury is the EBDR, which originates near the hamlet of Grand Gorge. The EBDR near its headwaters flows at a gentle slope of approximately 0.25 percent, running west and then south, parallel to NYS Route 30, through a series of beaver-impounded wetlands as it approaches the hamlet of Roxbury. Downstream of Roxbury, the EBDR continues south and west through Halcottsville and Margaretville before entering Pepacton Reservoir, part of the New York City water supply system. The EBDR flows generally parallel to the West Branch of the Delaware River and is broader and more branching than the West Branch. Several of the EBDR's tributaries have small lakes or ponds at their headwaters. Downstream of Pepacton Reservoir, the EBDR continues southwestward and joins with the West Branch near the New York/Pennsylvania border to form the Delaware River.

The EBDR has a watershed area of 23.8 square miles when measured at the downstream end of the hamlet of Roxbury (Figure 2-1). Land use within the watershed is dominated by forested land, making up over 80 percent of its total cover. Brushland together with grassland and agricultural land makes up about 15 percent while residential use comprises less than 3 percent of the watershed. Mean basin slope is flat within the project area at about 0.23 percent.

Soils are assigned a hydrologic soil group (HSG) identifier, which is a measure of the infiltration capacity of the soil. These are ranked A through D; an HSG A soil is often very sandy, with a high infiltration capacity and a low tendency for runoff except in the most intense rainfall events; a D-ranked soil often has a high silt or clay content or is very shallow to bedrock and does not absorb much stormwater, which instead is prone to run off even in small storms. A classification of B/D indicates that when dry the soil exhibits the properties of a B soil but when saturated it has the qualities of a D soil. Over 70 percent of the mapped soils in the EBDR watershed are classified as HSG C or D, indicating a low capacity for infiltration and high tendency for runoff (Figure 2-2). This contributes to flash flooding in the watershed as rainfall runoff moves swiftly into streams rather than gradually seeping through the soils. This is mitigated to some degree by the large areas of forest in the watershed, which tend to encourage infiltration and reduce runoff.

MXD: Q:\Projects\5197-15 Roxbury Grand Gorge LFA\GIS\MXD\EBDR Watershed.mxd



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

Watershed Map - East Branch Delaware River

Roxbury & Grand Gorge
Local Flood Analysis

Town of Roxbury
Delaware County, New York

SOURCE: 2013 National Geographic Society, i-cubed

DATE: OCTOBER 30, 2019
SCALE: 1"=5,000'
PROJ. NO.: 5197-15

Figure 2-1

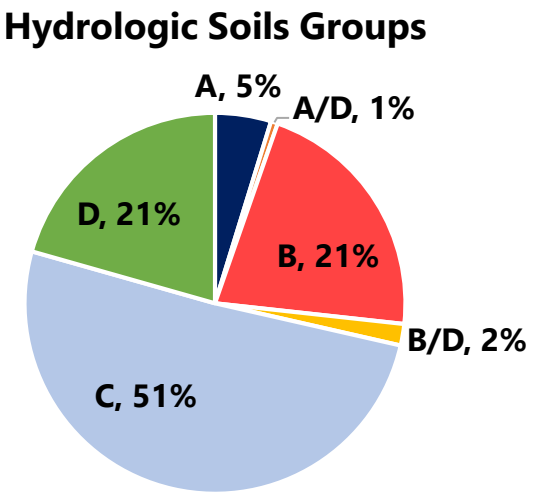


Figure 2-2
Hydrologic Soil Groups in EBDR Watershed

Two tributaries to the EBDR are of interest in this LFA. These are Pleasant Valley Brook and Vega Mountain Stream, both of which enter the EBDR in the hamlet of Roxbury. Pleasant Valley Brook flows into the EBDR near Kirkside Park and has a watershed area of 5.2 square miles with an average slope of approximately 2.6 percent (Figure 2-1). The brook has been historically altered near its confluence with the EBDR by the introduction of the railroad system and development in the floodplain. This area is subject to problematic sediment aggradation.

Vega Mountain Stream, which enters the EBDR about 500 feet upstream of Bridge Street, has a watershed area of 1.1 square miles (Figure 2-1). The watercourse is defined by a very steep and confined channel in the most upstream portion, with an average slope of nearly 9 percent. The stream becomes less confined as it enters the lower end of its watershed where historical human alterations of the channel have placed the stream within an unnatural stone-lined trapezoidal channel and directed it through a series of culverts. This portion of Vega Mountain Stream has been a repeated source of flood damage for Roxbury.

Figure 2-3 is a historic map of the hamlet of Roxbury dating from 1869, which shows the EBDR, Pleasant Valley Brook, and Vega Mountain Stream. Historically, the EBDR and its tributaries have been subject to alignment modifications throughout the years. For instance, in Figure 2-3, Pleasant Valley Brook is shown to have a more direct path toward the EBDR, which has been changed over the years leading up to its present configuration where it parallels the EBDR before joining it. Similarly, the section of the EBDR located between NYS Route 30 and Bridge Street has experienced significant changes in alignment due to the placement of the rail line and development in the floodplain. Figure 2-3 shows Vega Mountain Stream situated in approximately the same location in which it is found today.

Figure 2-3
Historic Map of the Hamlet of Roxbury, New York

Hamlet of Grand Gorge

The Bear Kill originates along the Schoharie and Delaware County Line and flows generally southeastward through Grand Gorge. The Bear Kill then flows to the south end of Schoharie Reservoir, part of the New York City water supply system. The Bear Kill has a watershed area of 18.3 square miles when measured at the downstream end of the Grand Gorge hamlet and an average slope of 0.8 percent (Figure 2-5).

Land use within the Bear Kill watershed is primarily forested and makes up more than 50 percent of the total land cover classification. Cropland and pastureland are second and combined form 40 percent of the watershed's land use. The hamlet of Grand Gorge is the only major source of urban development and covers less than 2 percent of total watershed land use. Over 80 percent of the mapped soils in the Bear Kill watershed are classified as HSG C or D, indicating a low capacity for infiltration and high tendency for runoff (Figure 2-4). This contributes to flash flooding in the watershed as rainfall runoff moves swiftly into streams rather than gradually seeping through the soils. This is mitigated to some degree by the large areas of forest in the watershed, which tend to encourage infiltration and reduce runoff.

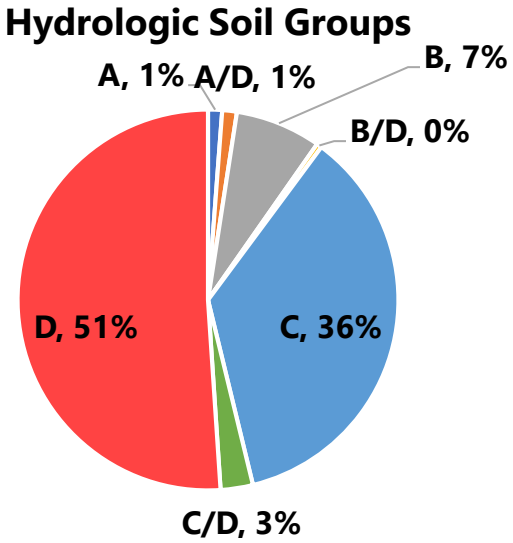
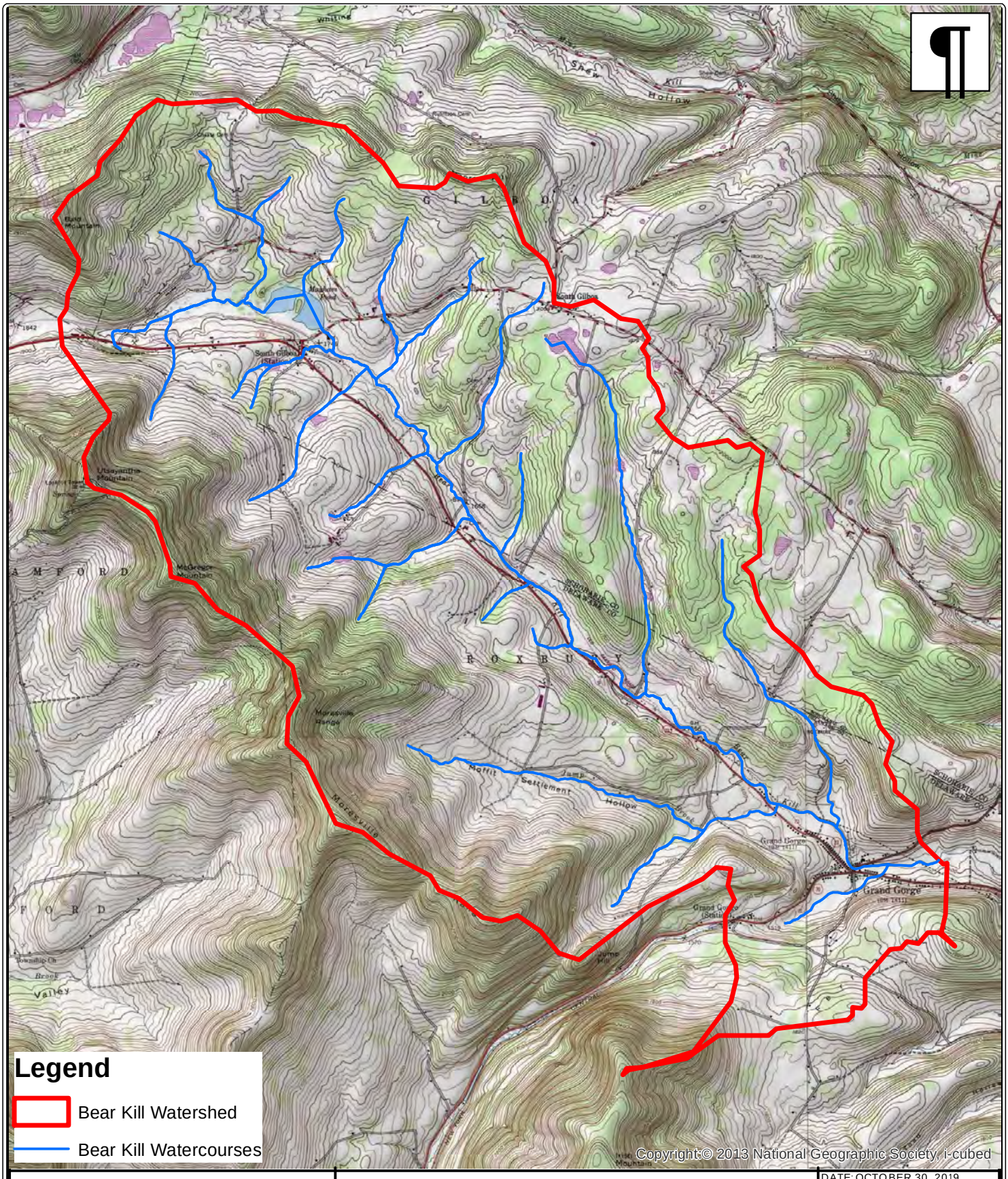


Figure 2-4
Hydrologic Soil Groups in Bear Kill Watershed

Grand Gorge was originally named Moresville after the More family, the first family to settle what is now the town of Roxbury in 1786. A historic map from 1869 (Figure 2-6) illustrates the Bear Kill as it flows through the hamlet with an alignment much like how it is seen today.

MXD: Q:\Projects\5197-15 Roxbury Grand Gorge LFA\GIS\MXD\GrandGorge_SoilsBearKill Watershed.mxd



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

Watershed Map - Bear KIll

Roxbury & Grand Gorge
Local Flood Analysis

Town of Roxbury
Delaware County, New York

SOURCE: 2013 National Geographic Society, i-cubed

DATE: OCTOBER 30, 2019
SCALE: 1"=4,43223'
PROJ. NO.: 5197-15

Figure 2-5

Figure 2-6
Historic Map – Hamlet of Grand Gorge, New York

2.2 Initial Data Collection

Initial data collected for this study and analysis included publicly available data as well as input from the FAC and from the public meetings held within the town of Roxbury. A summary of key documents follows.

FEMA Flood Insurance Study

FEMA has produced a Flood Insurance Study (FIS) dated June 16, 2016, for Delaware County. The purpose of the FEMA FIS is to determine potential floodwater elevations and delineate existing floodplains in order to identify flood hazards and establish insurance rates. For the Roxbury hamlet study area, the FIS includes a detailed study of the EBDR. The hydrologic and hydraulic analyses for EBDR were completed during the May 16, 2008, revision of the current FIS. During the 2016 revision, the EBDR was separated into two reaches. This LFA looks at EBDR Reach 2.

An important byproduct of the FIS is a series of *Hydrologic Engineering Center – River Analysis System* (HEC-RAS) computer models that are available for professional use and are an important component of the LFA. A key element of the HEC-RAS analysis is the determination of the area flooded during the 100-year frequency event, referred to as the SFHA. A detailed HEC-RAS model was created for the EBDR. Aside from one unnamed tributary located at the upstream end of the project area, all other tributaries to the EBDR within the study limits have not been mapped to identify their SFHA.

For the Grand Gorge hamlet study area, the Bear Kill has been evaluated by FEMA using approximate engineering methods only, meaning that identification of areas subject to flooding has been approximated, and no specific BFE has been identified by FEMA.

Stream Corridor Management Plan

For the Roxbury hamlet study area, a detailed description of the EBDR watershed is contained in the EBDR Stream Corridor Management Plan (SCMP) prepared by DCSWCD and the Delaware County Planning Department in cooperation with the NYCDEP. This report presents information on the climate, physiography, hydrology, stream characteristics, watershed geology, wetlands, historic and current land use, infrastructure, and flood history/response. A digital copy of this document is available at http://www.dcswcd.org/Watershed%20Plans.htm.

For the Grand Gorge hamlet study area, the Bear Kill is within the Schoharie Creek watershed. A detailed description of the Schoharie Creek watershed and channel is contained in the Schoharie Creek Stream Management Plan (SMP) prepared by the NYCDEP with assistance from the Greene County Soil and Water Conservation District (GCSWCD). This report presents information on the regional setting, climate, physiography, hydrology and flood history, watershed geology, and land use/land cover. A digital copy of this document is available at http://www.catskillstreams.org/Schoharie_Creek_Management_Plan.html. While the tributary streams are located within the Schoharie Creek watershed, they are not discussed in this SMP.

United States Geological Survey (USGS) Stream Gauging Network

The United States Geological Survey (USGS) operates a stream flow gauge within the town of Roxbury known as the 'East Branch Delaware River at Roxbury NY' gauge, (Gauge # 01413088). It is located on the right bank, approximately 10 feet downstream from the Route 30 crossing over the EBDR. The USGS does not operate a stream flow gauge within the hamlet of Grand Gorge. The nearest downstream USGS stream gauge is located on the Bear Kill near the confluence with Schoharie Reservoir. The gauge is known as the 'Bear Kill near Prattsville' gauge (Gauge #01350035). These 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 https://waterdata.usgs.gov/ny/nwis/sw.

Delaware County Multijurisdictional All-Hazard Mitigation Plan

The benefits of hazard mitigation plans (HMP) include but are not limited to the following:

- An increased understanding of hazards faced by communities
- A more sustainable and disaster-resistant community
- Financial savings through partnerships that support planning and mitigation efforts
- Focused use of limited resources on hazards that have the biggest impact on the community
- Reduced long-term impacts and damages to human health and structures and reduced repair cost (Tetra Tech, 2013)

Flood hazard mitigation planning is promoted by various state and federal programs. At the federal level, FEMA administers two programs that provide reduced flood insurance costs for communities meeting minimum requirements: the NFIP and the Community Rating System (CRS)

(Tetra Tech, 2013). Flood hazard planning is a necessary step in acquiring eligibility to participate in these programs (URS, 2009).

In 2013, Delaware County completed a multijurisdictional natural HMP. By participating in the plan, jurisdictions within the county comply with the Federal Disaster Mitigation Act of 2000. Compliance with this act allows jurisdictions to apply for federal aid for technical assistance and postdisaster mitigation project funding.

Hazards were ranked based on probability of occurrence and impact on the community. Delaware County was assigned an occurrence ranking of 'frequent' or '3' for flooding, indicating a hazard event that is likely to occur within 25 years. The impact ranking is determined based on the impact on population, impact on property (general buildings and critical facilities), and impact on the economy. A ranking of high, medium, or low is assigned to each of these factors based on historical losses and subjective assessment, and then used to calculate the overall ranking. Flooding in Delaware County was assigned a ranking of 'medium.' As a result, the overall hazard ranking for flooding in Delaware County is 'high.' The town of Roxbury was assigned an overall ranking for flooding of '3' (frequent) indicating an event is likely to occur within 25 years.

Water Quality Reports

In order to fulfill requirements of the Federal Clean Water Act, the New York State Department of Environmental Conservation (NYSDEC) must provide periodic assessments of the quality of the water resources in the state regarding 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 NYS. 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 subject LFA will focus on two watercourses in the project area: EBDR, which flows into the Pepacton Reservoir, and the Bear Kill, which flows into the Schoharie Reservoir. Both streams were classified by the NYSDEC as follows:

- EBDR Class C(T)
- Bear Kill Class C

A Class C waterbody is considered suitable to support aquatic life and noncontact activities but not for water supply. The additional standard of T indicates that the watercourse may support a trout population, and special requirements by NYSDEC apply to sustain these waters that support these valuable and sensitive fisheries resources.

According to the Delaware River Waterbody Inventory/Priority Waterbodies List (WI/PWL), which provides water quality assessment data for waterbodies in the Delaware River Basin, the segment of the EBDR from the Pepacton Reservoir to Roxbury is characterized as having minor impacts due to recreation and aquatic life that are known to be stressed by excessive nutrients. The sources of the nutrients are suspected to be on-site septic systems, agriculture, and stream bank erosion. The EBDR above Roxbury has not been assessed. This document can be found online at http://www.dec.ny.gov/chemical/36745.html.

According to the Mohawk River WI/PWL, which provides water quality assessment data for waterbodies in the Mohawk River Basin, the Bear Kill, which flows into Schoharie Reservoir, is listed as not having water quality impacts. This document can be found online at http://www.dec.ny.gov/docs/water_pdf/wimohawkbataviakill.pdf.

Neither of the watercourses in the LFA study area is listed in NYS's 2014 Section 303(d) inventory lists, a list of impaired waters that do not support appropriate uses.

Local Flood Damage Prevention Codes

The Town of Roxbury adopted a local Flood Damage Prevention Law in June 2016. The present code is authorized by the New York State Constitution and consistent with the federal guidelines, which are requirements for participation in the NFIP. The Town Code Enforcement Officer is empowered as the Local Administrator and is responsible for administering, implementing, and enforcing the local Flood Damage Prevention Law.

A copy of the document can be obtained from the Town of Roxbury upon request.

The stated purposes of this local law are as follows:

1. Regulate uses which are dangerous to health, safety, and property due to water or erosion hazards or which result in damaging increases in erosion or in flood heights or velocities.
2. Require that uses vulnerable to floods, including facilities that serve such uses, be protected against flood damage at the time of initial construction.
3. Control the alteration of natural floodplains, stream channels, and natural protective barriers which are involved in the accommodation of floodwaters.
4. Control filling, grading, dredging, and other development that may increase erosion or flood damages.
5. Regulate the construction of flood barriers that will unnaturally divert floodwaters, or which may increase flood hazards to other lands.
6. Qualify for and maintain participation in the NFIP.

The stated objectives of the local law are as follows:

1. To protect human life and health
2. To minimize the expenditure of public money for costly flood-control projects
3. To minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public
4. To minimize prolonged business interruptions
5. To minimize damage to public facilities and utilities such as water and gas mains; electric, telephone, and sewer lines; and streets and bridges located in areas of special flood hazard
6. To help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future flood blight areas
7. To provide that developers are notified that property is in an area of special flood hazard
8. To ensure that those who occupy the areas of special flood hazard assume responsibility for their actions

New York State Community Risk and Resiliency Act

The New York State Community Risk and Resiliency Act (CRRA) was adopted in 2014 for the purpose of ensuring that projects receiving state funding or requiring permits include consideration of the effects of climate risk and extreme-weather events.

To meet its obligation to develop guidance for the implementation of CRRA, NYSDEC has proposed a new document, State Flood Risk Management Guidance, which is intended to inform state agencies as they develop program-specific guidance to require that applicants demonstrate consideration of sea-level rise, storm surge, and flooding as permitted by program-authorizing statutes and operating regulations. The guidance incorporates possible future conditions, including the greater risks of coastal flooding presented by sea-level rise and enhanced storm surge and of inland flooding expected to result from increasingly frequent extreme precipitation events.

NYSDEC is also proposing a new guidance document entitled, "Guidance for Smart Growth Public Infrastructure Assessment." This new document is intended to guide state agencies as they assess mitigation of sea-level rise, storm surge, and flooding in design of public-infrastructure projects as required by CRRA.

In response to CRRA, the NYSDOT has provided updates to its guidelines and manuals relating to the design of bridges and culverts, including a revision to Chapter 8 of the *Highway Design Manual*, and a revised *Bridge Manual*. For new and replacement bridges and culverts, current peak flows are to be increased to account for future projected peak flows, which range from 10 to 20 percent. Bridges are required to pass the 50-year flow with a minimum of 2 feet of freeboard and must pass the 100-year flow without causing a rise in water surface elevations. Culverts must pass the 50-year flow and meet allowable headwater limits.

NYSDEC Stream Crossing Guidelines and Standards

The NYSDEC has developed stream crossing guidelines and standards aimed at protecting and restoring stream continuity. They provide minimum criteria to avoid fragmentation of streams. The objective is to maintain natural conditions that do not restrict the movement of fish and wildlife through the stream system.

These are summarized below and are available in more detail at:
https://www.dec.ny.gov/permits/49060.html
and:
https://www.dec.ny.gov/permits/49066.html

- Provide a minimum opening width of 1.25 times the bankfull width of the waterway in the vicinity of the culvert.
- Use open-bottom culverts or closed-bottom culverts that have the bottom slabs placed below the streambed elevation, which allows for installation of natural streambed material through the length of the culvert.
- Match the channel slope through the culvert to the natural channel slope upstream and downstream of the culvert.

- The culvert should not be skewed relative to the direction of flow of the stream.
- Install new or replacement structures so that no inlet or outlet drop would restrict aquatic organism passage.

Town of Roxbury Stormwater Assessment

In November 2006, the Town of Roxbury retained RETTEW Engineering and Surveying, LLC to conduct a stormwater infrastructure assessment of the hamlet of Roxbury using funding provided by CWC. The goal of the study was to identify locations where improvements of stormwater infrastructure would provide long-term benefits in water quality. Final recommendations considered optimal outcomes from three main categories – the reduction in water quality impairment related to impervious surface runoff, the impact of erosion/pollutants from the site on public health and drinking water supply, and the cost/benefit analysis of the project.

A total of 64 catch basins, 50 culverts, 18 swales, 6 storm sewer manholes, and 13 outfalls were identified in the study. Two of the culverts evaluated in this 2006 study overlap within the LFA project scope. This includes the culvert carrying Vega Mountain Road and the culvert inlet to the drainage network that runs under State Route 30. Only the latter was discussed in detail in the stormwater assessment report.

The overall conclusions of the assessment for the system under Route 30 were as follows:

- Preliminary hydraulic calculations indicated that the existing piping system under Route 30 is inadequate in size to accommodate the water volume produced by the 10-year design storm.
- Dual 60-inch stormwater pipes would safely convey the 10-year 24-hour design storm. If not feasible, the addition of a second 48-inch pipe would help to alleviate the flooding in this location however would not fully transport the volume of water from the 10-year design storm.

The installation for dual 60-inch culverts was ranked as number 4 on the project priority list. Priority was given to the project namely because of the following:

1. The need is immediate.
2. There are health and safety issues associated with the present condition.
3. Substation gains in water quality can be realized by rectifying the present conditions.

2.2.1 Field Assessment

During the LFA process, MMI staff conducted several field visits to the project area in winter, spring, and summer 2019. During these visits, various data were collected on several culverts, bridges, and the streams they cross; channel morphology, configuration, and floodplain characteristics; high-water marks; and other evidence of past flooding extents.

In the Roxbury project area, bridge opening measurements were collected for the structures over the EBDR and compared to the bridge geometry in the hydraulic model. Along Vega Mountain Stream, cross sections of the channel and culverts carrying the stream were measured and used to

create HEC-RAS hydraulic modeling. Cross sections were supplemented with a 2-meter-resolution Light Detection and Ranging (LiDAR)-derived Digital Elevation Model (DEM) available from the NYS Geographic Information System (GIS) Clearinghouse. For the culvert near the Vega Mountain Road-Johnson Road intersection, culvert dimensions and downstream cross-sections and profiles were measured for *HY-8* culvert hydraulic modeling.

In the Grand Gorge project area, inspection of the Bear Kill was conducted to inform hydraulic modeling and the alternative analysis. Fieldwork focused on identifying flood-prone areas and potential locations where mitigation alternatives would provide future flood relief. A field site walk was conducted with members of the Roxbury FAC for the purpose of visiting areas where floodplain enhancement is recommended and to visit other areas of interest in the stream corridor.

2.3 Critical Infrastructure and Anchor Businesses

An important component of the LFA information-gathering stage is the identification of critical facilities and anchor businesses. Critical facilities are defined as follows: public facilities such as a firehouse, school, town hall, drinking water supply treatment or distribution facility, or wastewater treatment plant or collection facility, which if destroyed or damaged would impair the health and/or safety of the community.

The known critical facilities in the Roxbury and Grand Gorge LFA project areas are listed in Table 2-1.

TABLE 2-1
Critical Municipal Facilities in the Project Areas

Facility	Address	Located in SFHA?
Roxbury Fire Department	53613 NN-30	Partially
Roxbury Central School	53613 NY-30	Partially
Roxbury Town Hall	53690 NY-30	No
Grand Gorge Fire Department	60753 NY-30	No

Anchor businesses are defined as follows: private gas stations, grocery stores, lumber yards, hardware stores, and medical doctor's office or pharmacy, which if destroyed or damaged would impair the health and/or safety of the community.

The known anchor businesses in the Roxbury and Grand Gorge LFA project areas are listed in Table 2-2.

TABLE 2-2
Anchor Businesses in the Project Areas

Facility	Address	Located in SFHA?
Sunoco Gas Station – Roxbury	53639 NY-30	No
WJOX FM Radio Station – Roxbury	2335 County Road 41	Yes
Sunoco Gas Station – Grand Gorge	NY-30 and NY-23	No

2.4 Hydrology

Hydrologic studies are conducted to understand historical and potential future river flow rates. Stream flow rates are a critical input for hydraulic models such as HEC-RAS. Stream flow is typically determined from USGS stream gauging stations or from regression equations based on variables such as precipitation and watershed area.

USGS operates and maintains stream flow gauges that record daily stream flow, including flood flows. This data is essential to understanding long-term trends. Gauge data can be utilized to determine flood magnitudes and frequencies. USGS stream flow data can be accessed on the National Water Information System (NWIS) mapper (https://maps.waterdata.usgs.gov/mapper/index.html). A total of four active USGS gauges are present along the EBDR, two of which are essential to the hydrology of the FEMA study reach. The upstreammost gauge is located within the project area in Roxbury (Gauge #01413088) with a record period of 17 years. The second is located downstream in Margaretville, New York, (Gauge #01413500) with 81 years of stream flow data. For the 2016 revision of the Delaware County FIS, detailed hydrologic and hydraulic analyses were conducted for the EBDR watershed and completed in September 2013. Given that the analysis period includes flow data from Tropical Storm Irene (August 2011) and that it was performed recently, the Delaware County FIS hydrologic data for the EBDR was used for this study. This is summarized in Table 2-3.

TABLE 2-3
Peak Discharges for EBDR in Roxbury (from FEMA FIS)

Location	Basin Areas (square miles)	Peak Discharges (cubic feet per second)				
		10-Year	25-Year	50-Year	100-Year	500-Year
Approximately 290 feet upstream of Teichman Road	8.26	1,011	1,390	1,723	2,073	2,968
At South Montgomery Hollow Road	9.03	1,066	1,478	1,840	2,219	3,188
At USGS Gauge 1413088	13.51	1,314	1,932	2,472	3,038	4,451
Approximately 175 feet downstream of State Highway 30	18.65	2,126	2,910	3,596	4,316	6,159
At Roxbury Central School driveway	19.09	2,199	2,995	3,691	4,422	6,297

Peak flows for Vega Mountain Stream were developed using *Hydrologic Engineering Center – Hydrologic Modeling System* (HEC-HMS) 4.3, a program that is designed to simulate the precipitation-runoff process of dendritic drainage basins. Rainfall data for Roxbury was obtained from the Northeast Regional Climate Center (NRCC) database administered by Cornell University. Extreme precipitation estimates for a 24-hour rainfall duration were used for the hydrologic model. In order to assess the structures along Vega Mountain Stream, peak discharges were calculated at three change-point locations along the stream reach including: (1) Upstream of the culvert near the Vega Mountain-Johnson Road intersection, (2) Upstream of the culvert carrying Vega Mountain Road, and (3) Upstream of the inlet pipe to the NYS Route 30 drainage structure. Table 2-4 summarizes the rainfall data used in the analysis and calculated peak flows for each change-point location.

TABLE 2-4
Rainfall Depths and Calculated Peak Discharges for Vega Mountain Stream in Roxbury

Storm Event (24-hour)	Rainfall Depth (inches)	Peak Discharges (cubic feet per second)		
		At Change-Point Location 1	At Change-Point Location 2	At Change-Point Location 3
1-Year	2.22	45	48	48
2-Year	2.68	97	105	105
5-Year	3.31	193	209	210
10-Year	3.89	298	324	325
50-Year	5.67	680	746	748
100-Year	6.68	923	1,014	1,017

For hydrology in the Grand Gorge LFA area, a Log-Pearson Type III distribution was computed for USGS gauge 01350035, located near Prattsville, New York, above Schoharie Reservoir. The gauge analysis was weighted with regional regression equations to compute the peak-flow rates at the gauge. The gauge analysis was transferred to discharge locations along the LFA project area using the area transfer method given in the 2006 USGS publication, "Magnitude and Frequency of Floods in New York." Peak-flow rates were calculated for the 10-, 25-, 50-, 100-, and 500-year recurrence intervals. A summary is listed in Table 2-5.

TABLE 2-5
Peak Discharges for Bear Kill in Grand Gorge

Location	Basin Areas (square miles)	Peak Discharges (cubic feet per second)				
		10-Year	25-Year	50-Year	100-Year	500-Year
Above confluence with Jump Brook	12.3	1,313	1,760	2,157	2,572	3,603
Approximately 290 feet downstream of State Highway 30	17.0	1,858	2,506	3,074	3,680	5,245
Approximately 1,300 feet downstream of State Highway 30	18.1	1,967	2,665	3,273	3,917	5,593
Approximately 3,000 feet downstream of Van Aken Road	19.1	2,075	2,812	3,457	4,145	5,930
At USGS Gauge 01350035	25.4	2,617	3,570	4,4401	5,294	7,606

3.0 EXISTING FLOOD HAZARDS

3.1 Flood History

The Catskill Mountains are subject to large storm events that are often unevenly distributed across watersheds. As a result, local flash floods can occur in one basin while an adjacent basin receives little rainfall. In addition to local flash floods, larger storm events can cause widespread flooding. An examination of stream flow gauges indicates that floods can take place any time of the year but are commonly divided into those occurring in winter and spring and those occurring in summer and fall. Floods that take place in summer and fall are typically due to extreme rainfall events caused by hurricanes and tropical storms. Floods in winter and spring are associated with rain-on-snow events and spring snowmelt (FEMA, 2015).

Two significant flood events that affected the hamlets of Roxbury and Grand Gorge occurred in January 1996 and August 2011. The first was a rain-on-snow event where unseasonably warm weather produced significant melting of the snow pack combined with heavy rain, resulting in widespread flooding (USGS, 1998). The January 1996 event resulted in more than $120 million in individual and public disaster assistance throughout NYS.

On August 28, 2011, Tropical Storm Irene caused extensive flooding and devastation in eastern New York. Flooding throughout the entire Catskill region was widespread, and FEMA estimated that statewide damages were approximately $102 million. Following the flood, $15.2 million in state and federal aid was allocated to 377 municipalities in the state (GCSWCD, 2007). In the town of Roxbury, as shown in Figure 3-1, Tropical Storm Irene was the flood of record captured at the EBDR gauge for this given year. Hydrologic comparison indicates that peak flow at the gauge for the 2011 storm was less than the FEMA estimated peak discharge for a 10-year storm. Public recollection of the 2011 storm described floodwaters from the EBDR as being significantly less severe compared to previous flood events such as the 1996 flood.

Similarly, the Bear Kill in the hamlet of Grand Gorge was said to not have caused severe flood damage during Tropical Storm Irene. Comparison of annual peak discharges at the Schoharie gauge is depicted in Figure 3-2. During Tropical Storm Irene, flows on the Bear Kill gauge reached a peak discharge of 2,000 cubic feet per second (cfs), almost equivalent to a 10-year event. During witness meetings, recollection of the 1996 flood evoked a larger response than Tropical Storm Irene. The 1996 storm event was described as having caused substantial flood damage to properties in the hamlet. Throughout the LFA process, there was also mention of seasonal ice jams leading to flooding of a few properties along the Bear Kill reach. Beaver dams also were pointed out as issues for the hamlet although they are often preemptively removed by the town in order to prevent the dams from bursting and causing property damage downstream.

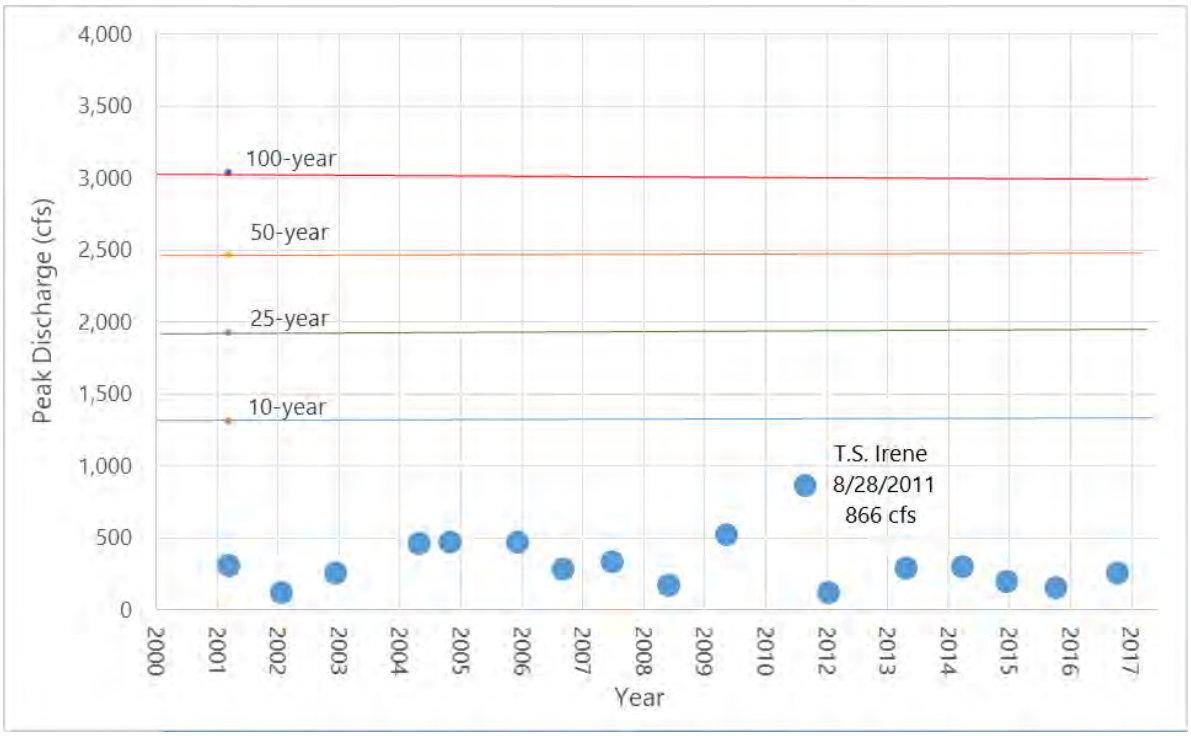


Figure 3-1
Annual Peak Discharge at USGS Gauge #01413088 in Roxbury, New York, Compared to FEMA Discharges from Delaware County FIS, Effective June 2016

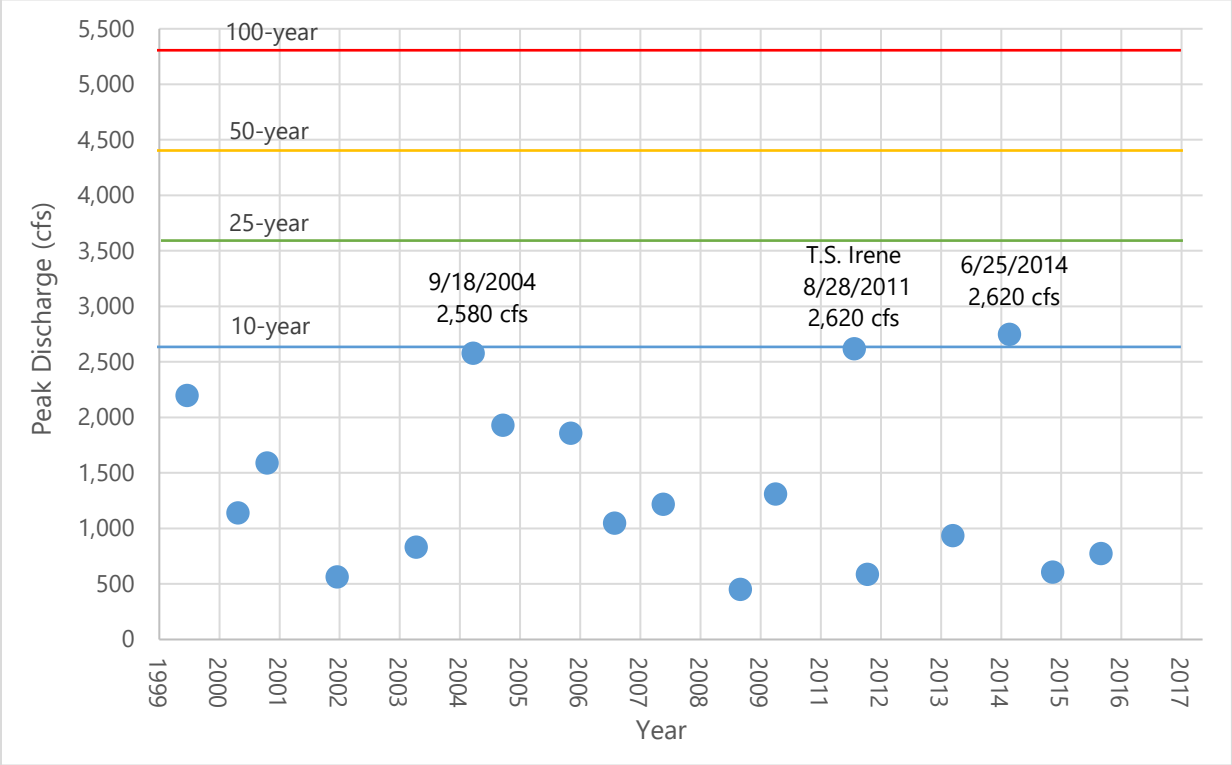


Figure 3-2
Annual Peak Discharge at USGS Gauge #01350035 near Prattsville, New York, Compared to Calculated Weighted Peak Discharges at the Gauge Site using Regional Regression Equations

3.2 Flood History Along Vega Mountain Stream

Drainage from Vega Mountain is extremely problematic in the hamlet of Roxbury, especially at the Vega Mountain Road crossing. Multiple recollections described instances where floodwaters escaped the channel and runoff traveled down Vega Mountain Road, damaging a series of homes and businesses in the area. In the wintertime, ice formation and accumulation often occur in sections of the channel that are lined with flat bedrock slabs and impede water from progressing downstream. Water that is backed up by the buildup of ice then spills over the left bank of the channel causing water to flow down Vega Mountain Road.

During community meetings, the watercourse was described as a persistent flooding issue within the hamlet even during minor storm events. Flooding is only exacerbated during large rainstorms, resulting in widespread inundation at the heart of the hamlet. The following series of photos captured by the public during Tropical Storm Irene illustrates the flood extent due to the large volume of water coming from Vega Mountain Stream. Additional details about this tributary to the EBDR are discussed in Sections 4.6 and 6.0 of this report.

Figure 3-3
Looking Upstream, Vega Mountain Stream near Vega Mountain Road Crossing during Tropical Storm Irene

Figure 3-4
High-Velocity Floodwaters Traveling Down Vega Mountain Road toward NYS Route 30; Energy Dissipation Causes a Hydraulic Jump at Intersection

Figure 3-5
(Facing South on NYS Route 30 near Roxbury Fire Department Building)
Vega Mountain Stream Floodwaters Traveling across the Backyards of Homes North of Route 30 and Flooding Main Street

Figure 3-6
(Facing West, Down Bridge Street Bridge) In Typical Fashion, Vega Mountain Stream Floodwaters Flowing down Bridge Street Bridge toward the EBDR

3.3 FEMA Mapping

FEMA FIRMs are available for the Roxbury study area and depict the SFHA, which is the area inundated by flooding during the statistical 100-year flood event. The maps also depict the FEMA-designated floodway along EBDR, 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).

Many of the tributaries to the EBDR in the study area have not been mapped to identify their SFHA; this includes Pleasant Valley Brook and Vega Mountain Stream.

FEMA FIRMs that are relevant to the Roxbury project area include 36025C0415E and 36025C0420E, effective June 16, 2016. These maps address the following areas:

- 36025C0415E: This FIRM covers the EBDR from Cold Spring Road upstream to Kirkside Park and the Pleasant Valley Brook confluence.
- 36025C0420E: This FIRM covers the EBDR from its Pleasant Valley Brook confluence upstream to the vicinity of Teichman Road.

The Bear Kill in the hamlet of Grand Gorge was modeled using approximate methods, and the FIRMS only depict the SFHA. The floodway is not delineated.

FEMA FIRMs 36025C0410E and 36025C0430E cover the full extent of mapping available for the Bear Kill in the hamlet of Grand Gorge. These FIRMs have an effective date of June 16, 2016. The maps address the following areas:

- 36025C0430E: This FIRM covers the Bear Kill from its confluence with Schoharie Reservoir upstream to Park Lane.
- 36025C0410E: This FIRM covers the Bear Kill from Park Lane upstream to the vicinity of Turk Hill Road.

The FIRMs are accessible to the public on the FEMA Flood Map Service Center website (https://msc.fema.gov/portal).

4.0 FLOOD MITIGATION ANALYSIS

The purpose of a hydraulic assessment is to evaluate historical and predicted water surface elevations, identify flood-prone areas, and help develop mitigation strategies to minimize future flood damages and protect water quality. Hydraulic analysis techniques can also help predict flow velocities, sediment transport, scour, and deposition if these outcomes are desired.

Specific areas within the hamlets of Roxbury and Grand Gorge have been identified as being prone to flooding during severe rain events. Several alternatives were developed and assessed at areas where flooding is known to have caused extensive damage of homes and properties. Alternatives were assessed with hydraulic modeling to determine their effectiveness. The narrative below describes the alternatives and the results of modeling analysis.

4.1 Analysis Approach

Hydraulic analysis of the EBDR, Vega Mountain Stream, and the Bear Kill was conducted using the HEC-RAS hydraulic modeling program. The HEC-RAS software (*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.

In order to carry out hydraulic modeling of baseline conditions and alternatives, MMI obtained the effective FEMA HEC-RAS model for EBDR from the NYCDEP. This HEC-RAS model provided the starting point for the current analysis. A duplicate effective model was created for EBDR. The output of the duplicate effective model was compared to the model provided by the NYCDEP and found to be identical. Additionally, the water surface elevations of the HEC-RAS models were compared to those published in Table 10 of the Revised FEMA FIS and the online FIRMs and verified for accuracy.

MMI developed a one-dimensional steady state hydraulic model for Vega Mountain Stream in order to comprehend the flood concerns that were described by stakeholders at LFA meetings. The modeled reach is approximately 1,200 feet in length, beginning at the confluence with the EBDR and ending approximately 370 feet upstream of the Vega Mountain Road crossing. The operational model was used to evaluate the hydraulic capacity of the Vega Mountain Road culvert and the system of culverts that runs under NYS Route 30. Flood mitigation alternatives were also assessed using this model.

For the Grand Gorge study area, a hydraulic model for the Bear Kill was obtained from the DCSWCD. The HEC-RAS model was developed by another group of consultants during prior efforts to have the FEMA approximate Zone A remapped for the hamlet. MMI vetted the hydraulic model, made any necessary changes accordingly, and developed a duplicate model. The duplicate model served as the baseline model for evaluating existing conditions and proposed flood mitigation alternatives.

Analysis was conducted for the Johnson Road culvert in Roxbury using the U.S. Department of Transportation – Federal Highway Administration (FHWA) hydraulic analysis program *HY-8*. This software is capable of modeling culverts of various slopes, lengths, sizes, materials, and shapes and is used to compute capacities, rating tables, and hydraulic properties for highway-type culverts. It can be used in settings with inlet control and outlet control in any flow regime from partial depth, full depth, surcharged, or roadway overtopping. Methods used are those generally described in the publication *Hydraulic Design of Highway Culverts*.

4.2 Flood Mitigation Alternatives

Several flood mitigation approaches to reduce water surface elevations were evaluated in the project area. These are listed below and described in more detail in the sections that follow.

- Bridge improvements
- Culvert improvements
- Floodplain enhancement

In addition to the flood mitigation approaches listed above, which seek to reduce or eliminate flood damages by reducing water surface elevations, flood protection measures for individual properties were explored. These scenarios were evaluated case by case and seek to reduce flood-related damages by either relocating, floodproofing, or elevating homes and businesses located in flood-prone areas.

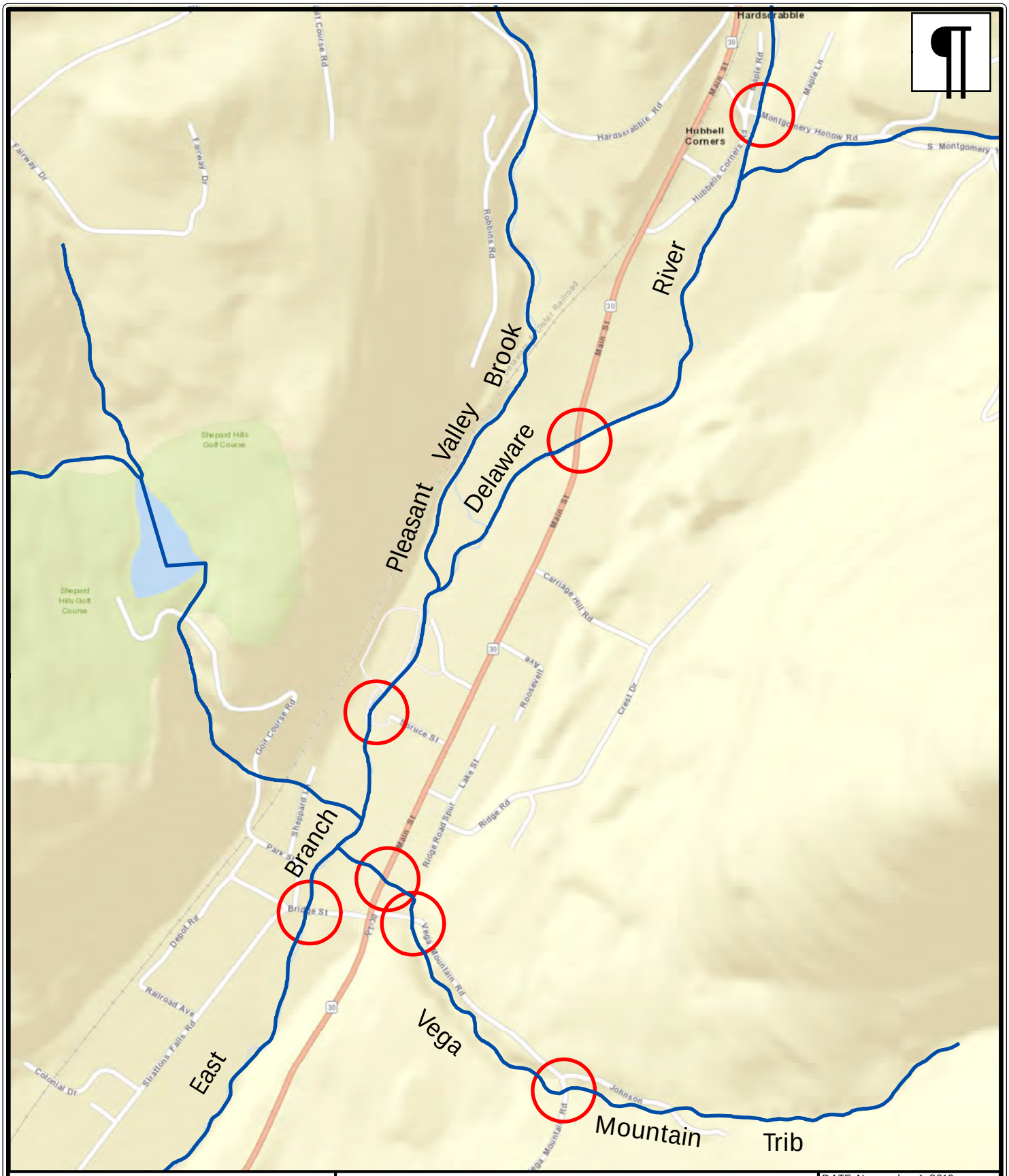
4.3 Bridge Improvement Assessment

Inadequately sized bridges can be overtopped or flanked by floodwaters during a flood event. This can create a safety hazard for travelers and can cut off important evacuation and emergency access routes. Undersized bridges can act as hydraulic constrictions, exacerbating flooding during high-flow events by increasing water surface elevations upstream of the bridge.

For the purpose of this LFA, each bridge was evaluated to determine whether it would be overtopped or flanked during a flood event. Bridges were also assessed by removing the bridges from the hydraulic model. This simulates the complete removal of the bridge from the channel. If removal of a bridge from the model results 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 is evaluated and advanced for consideration.

Four bridges on EBDR and one bridge on the Bear Kill were evaluated, and the modeling results for each bridge are discussed in the sections that follow. The bridge locations for Roxbury and Grand Gorge are shown in Figures 4-1 and 4-2, respectively.

MXD: Q:\Projects\5197-15 Roxbury Grand Gorge LFA\GIS\MXD\Roxbury\Crossings.mxd



MILONE & MACBROOM

231 Main Street, Suite 102
New Paltz, New York 12561
(845) 633-8153
www.mminc.com

Stream Crossing Locations - Roxbury

Roxbury & Grand Gorge
Local Flood Analysis

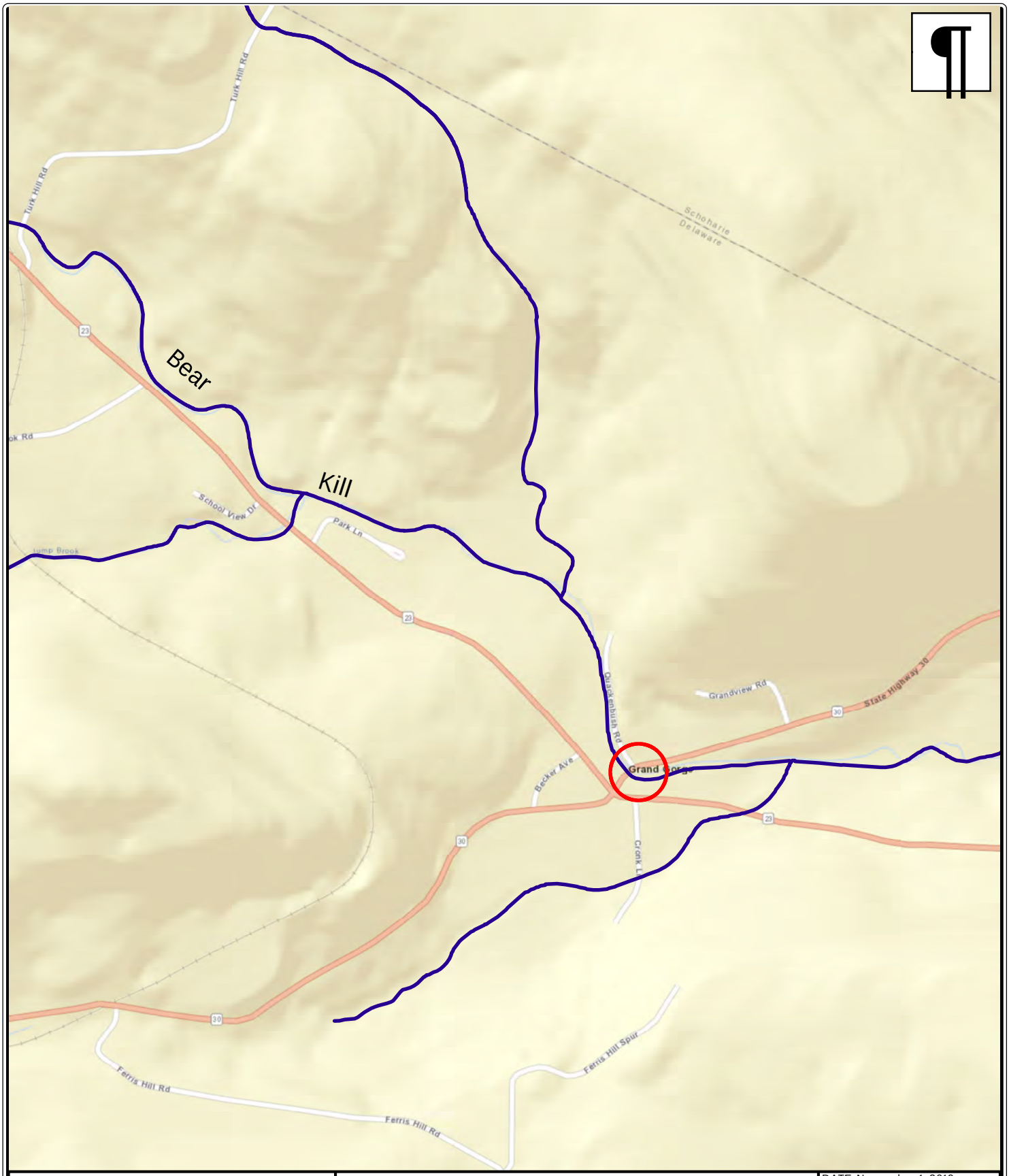
Town of Roxbury
Delaware County, New York

SOURCE: ESRI Worlwide Street Map

DATE: November 1, 2019
SCALE: 1"=1000'
PROJ. NO.: 5197-15

Figure 4-1

MXD: Q:\Projects\5197-15 Roxbury Grand Gorge LFA\GIS\MXD\GrandGorgeCrossings.mxd



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

Stream Crossing Locations - Grand Gorge

Roxbury & Grand Gorge
Local Flood Analysis

Town of Roxbury
Delaware County, New York

SOURCE: ESRI Worlwide Street Map

DATE: November 1, 2019
SCALE: 1"=1000'
PROJ. NO.: 5197-15

Figure 4-2

4.3.1 North Montgomery Hollow Road

The Montgomery Hollow Road structure crosses the EBDR at the most upstream end of the LFA project area. This structure connects Montgomery Hollow to Hubbell Corners Road, which then connects to NY-30. The bridge is of service to residential homes located to the east and is the only means of connection to Roxbury west of the EBDR; no detours are available.

Hydraulic modeling indicates that the Montgomery Hollow Road bridge conveys the 10-, 25-, and 50-year flood events and is flanked to its left (east) by floodwaters during the 100- and 500-year flood events. Modeling the removal of the structure and the roadway embankment to its left showed reductions in water surface elevations upstream ranging from 0.5 – 1.6 feet for higher magnitude floods. During higher flows, when water overtops the left bank, the roadway embankment acts as a dam and contributes to the impoundment of water upstream of the bridge.

The bridge deck is rarely overtopped given that it is at a significantly higher elevation than the adjacent roadway along the left floodplain; this is clearly shown in Figure 4-3. The area along EBDR upstream of the bridge is sparsely developed with a few houses on the left overbank along Maple Lane. During LFA meetings, this bridge was established to be a minimal area of concern, and there was no mention of the homes flooding in the past.

The North Montgomery Hollow Road bridge is not a high priority for immediate replacement. However, when the bridge is due for a regularly scheduled replacement, the new bridge should be adequately sized so that the 100-year flood can safely pass without overtopping the adjacent roadway. Recommendations are discussed in Section 6.0.

Figure 4-3
North Montgomery Road Bridge over EBDR

4.3.2 NYS Route 30 Bridge (Hamlet of Roxbury)

NYS Route 30 (Figure 4-4) runs from north to south through the hamlet of Roxbury and is a central road for means of transportation in and out of town. No reports of the roadway overtopping have been received at this location. Hydraulic modeling indicates that the structure can safely pass the 10-year flood. Flows are constricted by the bridge abutments and road embankment during the 25- and 50-year storms, resulting in backwaters extending 2,000 feet upstream to flood nearby fields. Potential for flooding on the roadway to the north during the 100-year storm was also shown.

Figure 4-4
NYS Route 30 Bridge in Roxbury, New York, over EBDR

The Route 30 bridge over the EBDR acts as a hydraulic constriction resulting in an increase in water surface elevations upstream of the bridge. However, the backwaters caused by the bridge are only contributing to flooding of pasture fields located upstream, posing little to no threat during storm events and therefore lowering its overall priority for replacement. The NYS Route 30 bridge is not a high priority for immediate replacement. However, when the bridge is due for a regularly scheduled replacement, it should be adequately sized so that the 100-year flood can safely pass without danger of overtopping the adjacent roadway. Recommendations are discussed in Section 6.0.

4.3.3 Roxbury Central School Bridge

The bridge spanning the EBDR behind the Roxbury Central School building (Figure 4-5) provides access to the school's baseball fields and tennis courts. The structure in place was rebuilt approximately 10 years ago and designed to withstand greater traffic loads in order to allow for emergency vehicles to pass. Hydraulic modeling indicates that the bridge is only able to pass the 10-year storm and is flanked and overtopped in all other flows. The bridge is mildly constrictive to flows during lower-magnitude, higher-frequency storm events although this is not the case for

higher-magnitude, lower-frequency events when conveyance is entirely overland flow and the bridge is no longer a constriction.

Figure 4-5
Bridge Behind Roxbury School over EBDR

Aside from regular inspection and maintenance, no further actions are recommended at the Roxbury School bridge.

4.3.4 Bridge Street (County Route 41) Bridge

County Route 41 (more commonly referred to as the Bridge Street bridge) crosses the EBDR near the Roxbury Hotel. The structure has a horizontal span of 38 feet with an average 10.5-foot vertical opening. The channel banks upstream and downstream of the bridge have been lined with large boulders, portions of which were seen to begin sloughing. During Tropical Storm Irene, water on the EBDR reportedly reached the low chord and also flanked the bridge to its left (Figure 4-6). Water backed up at the bridge resulting in flooding of the adjacent roadway and nearby homes, reportedly with over a foot of water. Water spilling out of Vega Mountain Stream and flowing down Vega Mountain Road across Main Street and down Bridge Street also contributed to flooding in this area.

Figure 4-6
Bridge Street Bridge over EBDR during Tropical Storm Irene

Hydraulic modeling of the Bridge Street bridge indicates that the structure is acting as a major constriction, more clearly seen during lower-magnitude, higher-frequency flows such as the 10-year event. In this scenario, floodwaters are not only constricted by the structure itself but also by the severely undersized channel in the vicinity of the bridge. Removal of the bridge from the model for the 10-year storm event results in water surface elevation reductions of 1.5 feet at the upstream face of the bridge. The reduction diminishes moving upstream of the bridge and is negligible at a point approximately 3,500 feet upstream (Figure 4-7).

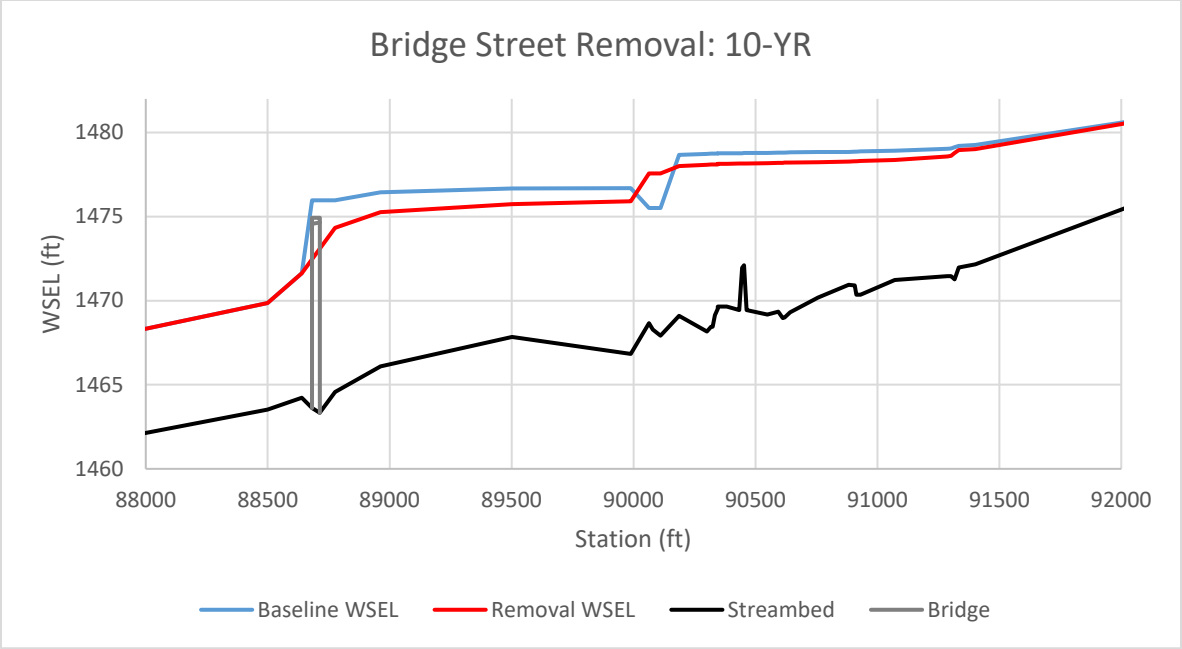


Figure 4-7
Longitudinal Profile – 10-Year Flood
Bridge Street Bridge over EBDR

Lesser flood mitigation benefits are seen for the 25-, 50-, and 100-year recurrence intervals. This is because the existing bridge gets significantly flanked to its left at these stages, and the majority of the flow conveyance occurs on the left overbank. Removal of the existing structure is not enough to offset for the undersized channel and embankment encroaching on floodwaters upstream of the structure. Resulting water surface elevations from the bridge removal can be seen in longitudinal profile form in Figures 4-8 and 4-9 for the 50- and 100-year storm events, respectively. In order to optimize flood mitigation benefits at this crossing, enhancement of the floodplain upstream and downstream of the bridge, along with replacing the bridge with a larger structure, is advisable.

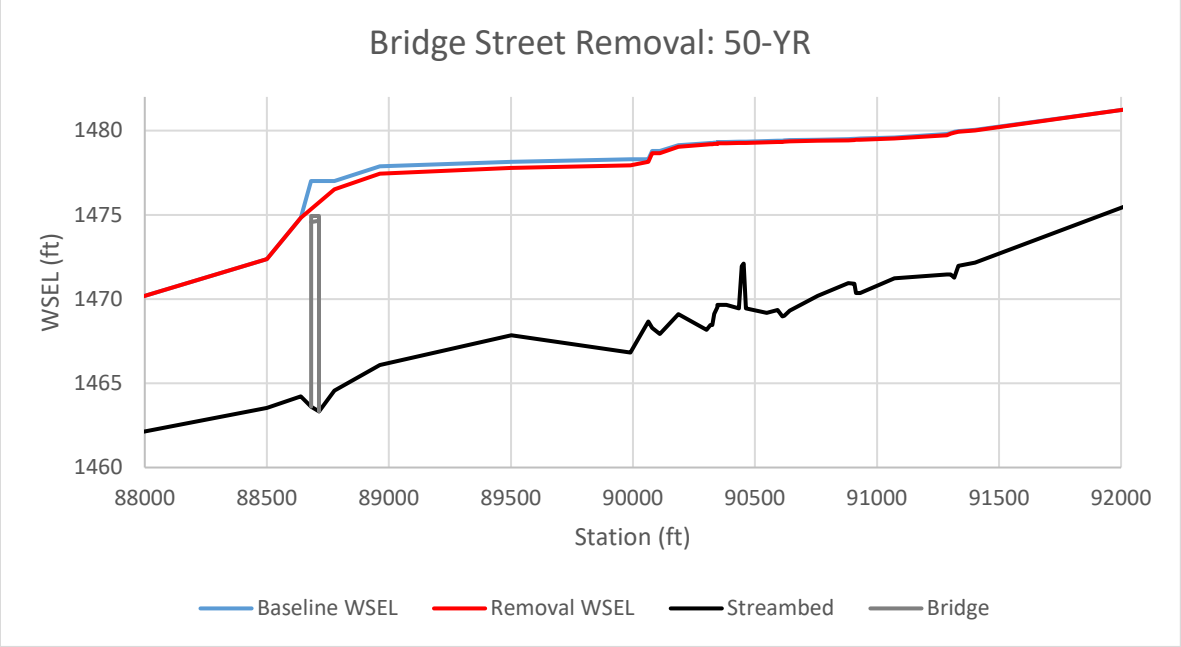


Figure 4-8
Longitudinal Profile – 50-Year Flood
Bridge Street Bridge over EBDR

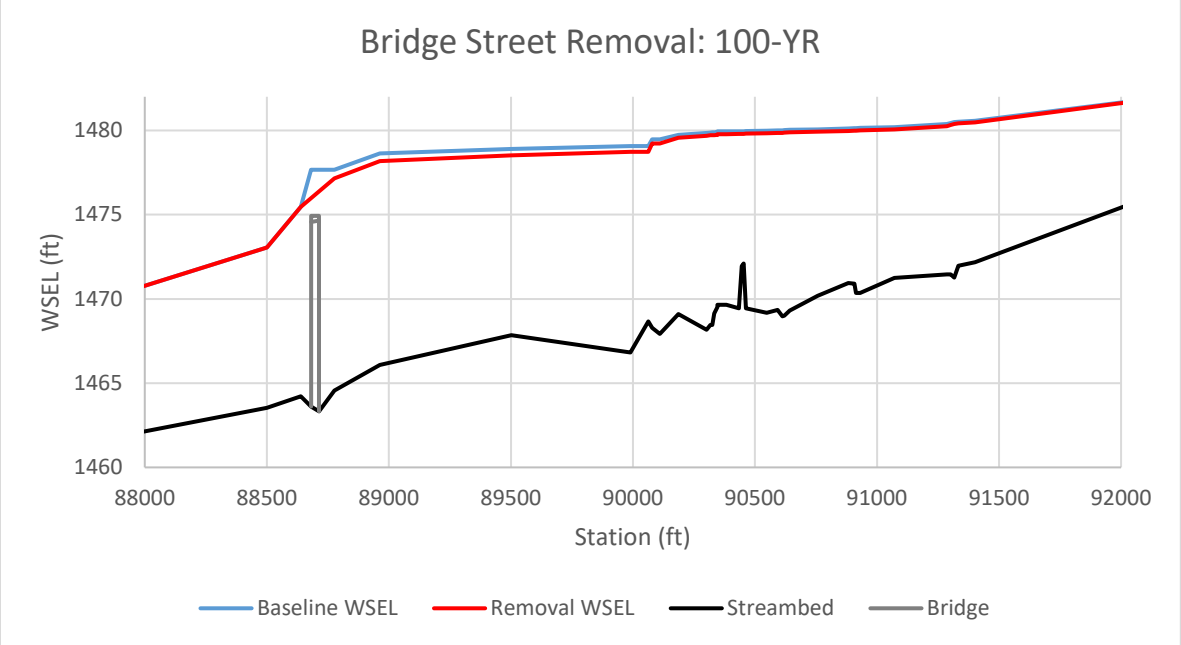


Figure 4-9
Longitudinal Profile – 100-Year Flood
Bridge Street Bridge over EBDR

The Bridge Street bridge should be a high priority for replacement. When replaced, it is recommended that the new bridge be adequately sized so that the 100-year flood can safely pass

without flanking the bridge or causing a rise in water surface elevations. The channel and associated floodplain should also be evaluated and enhanced as necessary. Floodplain enhancement is discussed in more detail in Section 4.4. Recommendations are discussed in Section 6.0.

4.3.5 NYS Route 30 Bridge (Hamlet of Grand Gorge)

NYS Route 30 runs north/south and connects the Bear Kill valley to the EBDR valley. The Route 30 bridge (Figure 4-10) in Grand Gorge crosses the Bear Kill approximately 200 feet north of where Route 30 meets NYS Route 23. The bridge was constructed in 1931 and has a 40-foot span and 6.5-foot rise. No reports of flooding or roadway overtopping were received for this bridge. Hydraulic modeling indicates that the structure is a hydraulic constriction to flows, only able to convey the 10-year flood with no freeboard. Although the structure is hydraulically undersized, it does not contribute to flooding of upstream homes or businesses.

Visually, the Route 30 bridge appears to be in poor condition. Defoliating steel concrete forms under the superstructure, and spalling concrete, were observed in the field. For the next replacement bridge, it is recommended that a full hydrologic and hydraulic study be conducted to adequately size the new replacement structure to comply with NYSDOT design standards.

Figure 4-10
NYS Route 30 Bridge over the Bear Kill in Grand Gorge

4.3.6 Summary of Bridge Removal Analysis

Table 4-1 summarizes the results for the hydraulic analysis of bridges within the LFA project area.

TABLE 4-1
Summary of Bridge Hydraulic Findings within LFA Project Areas

Watercourse	Bridge Crossing	Bridge or Roadway Overtops in the 50-Year Event (Y/N)	Bridge or Roadway Overtops in the 100-Year Event (Y/N)	Bridge Contributes to Upstream Flooding (Y/N)
EBDR	North Montgomery Hollow Road	**N**	**N**	**Y**
EBDR	NYS Route 30	**Y**	**Y**	**N**
EBDR	Roxbury Central School Bridge	**Y**	**Y**	**N**
EBDR	Bridge Street (County Route 41)	**Y**	**Y**	**Y**
Bear Kill	NYS Route 30	**Y**	**Y**	**N**

4.4 Floodplain Enhancement Assessment

Historical settlement and human desire to build near water have led to centuries of development clustered along the banks of rivers all over the nation, including along the EBDR in Roxbury and the Bear Kill in Grand Gorge. Dense development and placement of fill in the natural floodplain of a river can severely hinder a river's ability to convey flood flows without overtopping its banks and/or causing heavy flood damages. 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.

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 removing 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.

Figure 4-11 shows a typical cross section of a compound channel with excavated floodplain benches on both banks. The graphic illustration shows flood benches on both banks; however, flood benches can occur on either or both banks of a river.

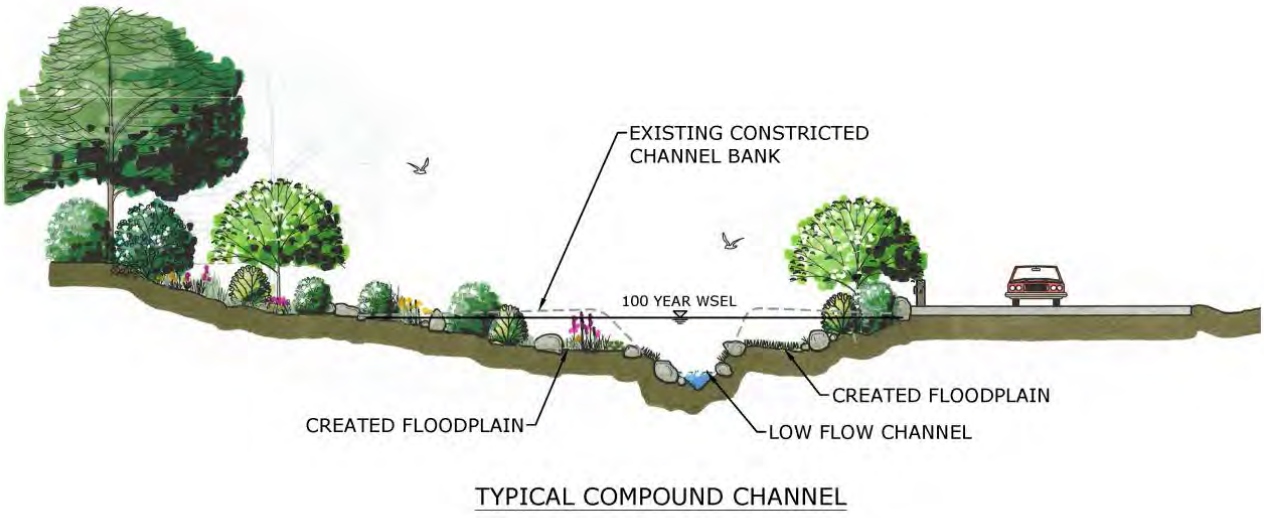


Figure 4-11
Cross Section of a Compound Channel with Enhanced Floodplain

Floodplain enhancement scenarios were evaluated along the EBDR at the Bridge Street bridge in Roxbury and along the Bear Kill in Grand Gorge. These scenarios are depicted on Figure 4-12 and Figure 4-13. Detailed descriptions of each scenario follow.

Figure 4-12
Floodplain Bench Enhancement along the EBDR at the Bridge Street Bridge, Hamlet of Roxbury

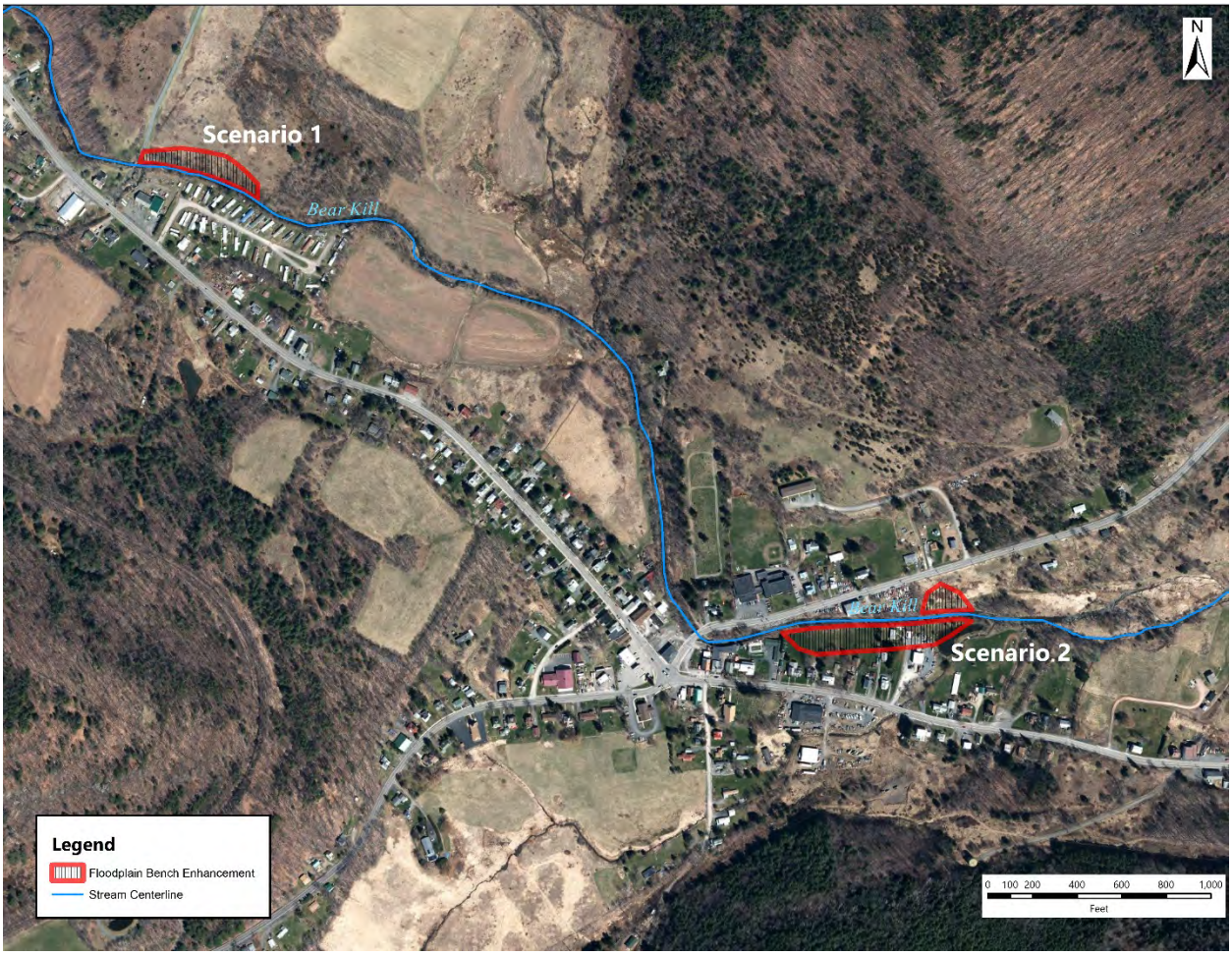


Figure 4-13
Areas of Floodplain Bench Enhancement along the Bear Kill,
Hamlet of Grand Gorge

4.4.1 Assessment of Bridge Improvement and Floodplain Enhancement – Bridge Street Bridge, Hamlet of Roxbury

This scenario would entail increasing the span of the existing bridge and constructing a floodplain bench by lowering the left floodplain near the structure. The floodplain bench would begin upstream at an existing choke point to the EBDR, extend through the replacement bridge, and continue downstream where it connects to an existing low-lying floodplain area. Under this scenario, downstream of the bridge, a small gazebo would need to be relocated elsewhere, and a part of a parking lot would be excavated down to a lower elevation. Excavation of the left floodplain upstream of the bridge would take place on existing grassed area. In return, this effort would convey flows during flood events, creating more space for floodwaters to be conveyed downstream without flooding inhabited areas in the vicinity.

For the purpose of analysis, a hydraulic simulation using a proposed 60-foot bridge span and a floodplain bench through the structure was performed and compared to the baseline model. The proposed layout was determined in the field and is based on the room available to upsize the

bridge, widen the channel, and create a floodplain bench without disturbing existing buildings near the bridge. The modeled floodplain bench measured 400 feet in length and 40 feet in width and considered a maximum excavation depth of 4 feet. Inundation mapping depicts the depth and extent of flooding during the 50-year event with the existing and proposed bridge configuration (Figures 4-14 and 4-15).

The longitudinal profile in Figure 4-16 compares water surface elevations from the Bridge Street bridge removal analysis in Section 4.4.4 to the resulting water surface elevations of the proposed bridge improvement and floodplain bench enhancement scenario. Incorporating a floodplain bench into the design results in additional upstream water surface elevation reductions of 1.5 feet for the 50-year discharge, extending for approximately 3,500 feet upstream before fully diminishing. Reductions in the magnitude of 1.5 feet are also seen on the downstream side of the proposed structure configuration and extend for 1,085 feet.

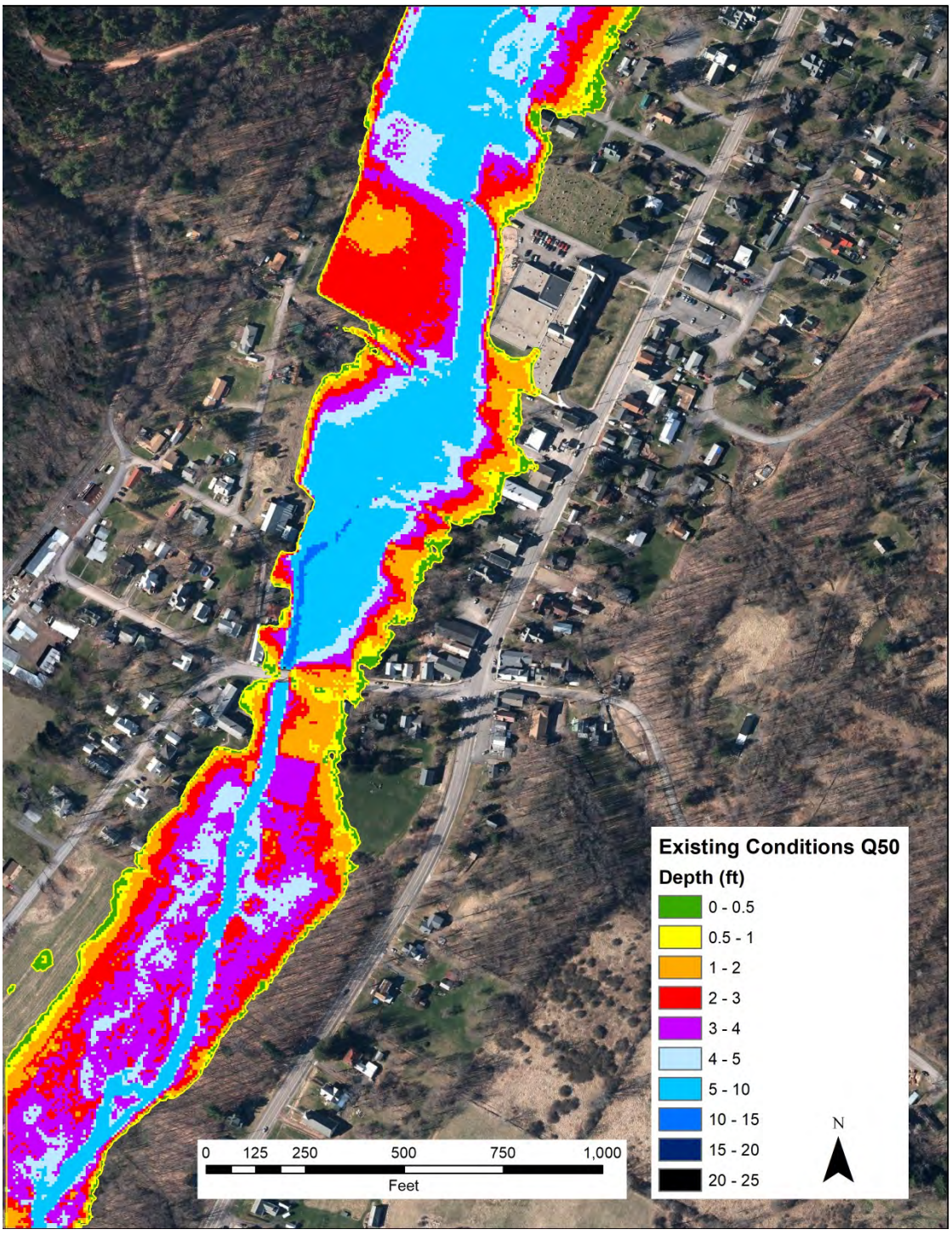


Figure 4-14
Depth Grid Mapping at Bridge Street Bridge – 50-Year Flood
Existing Conditions

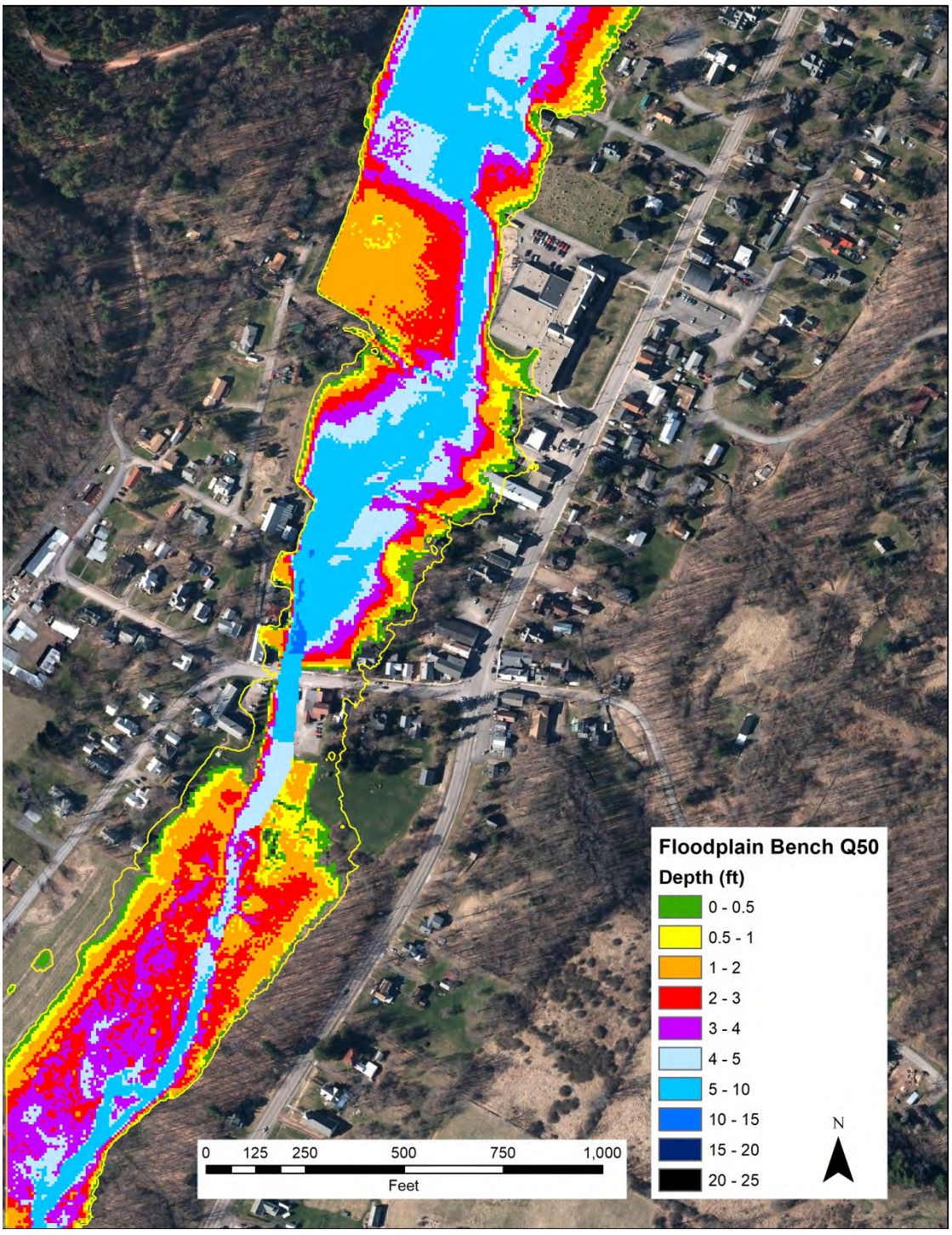


Figure 4-15
Depth Grid Mapping at Bridge Street Bridge – 50-Year Flood
Proposed Conditions

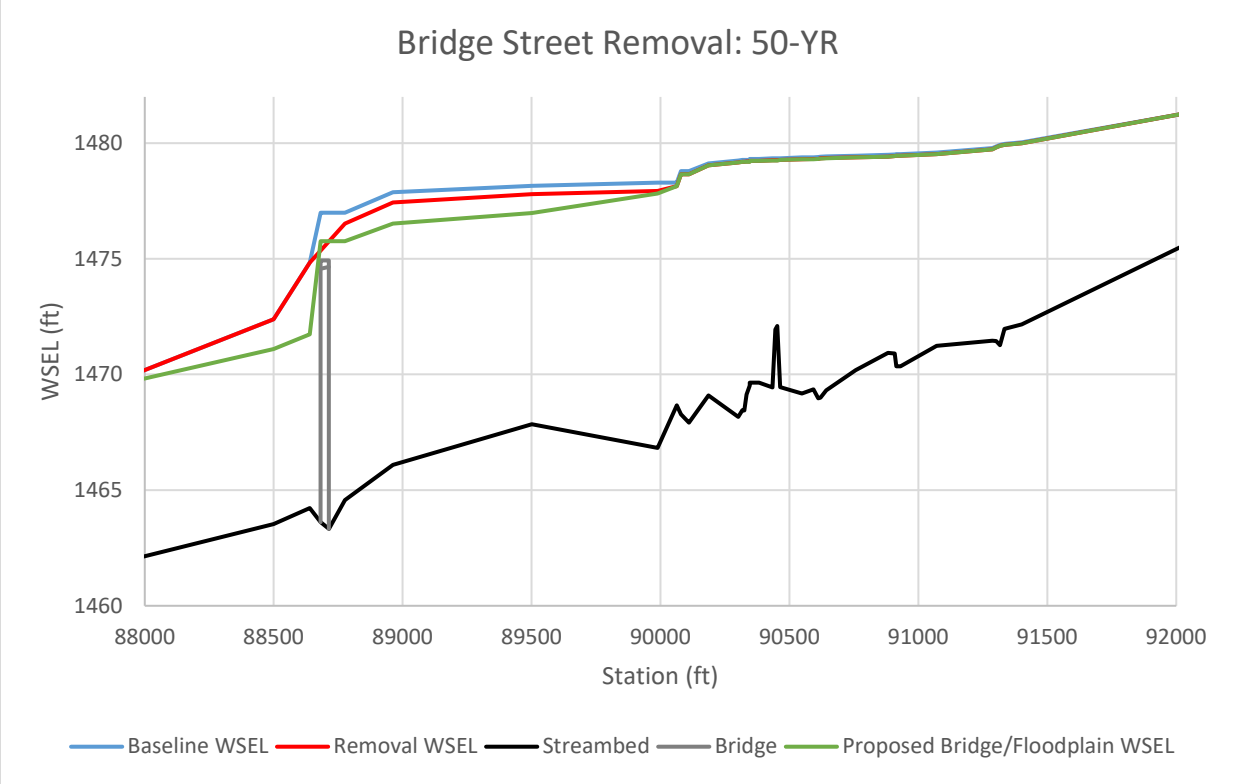


Figure 4-16
Longitudinal Profile – 50-Year Flood
Bridge Street Bridge over EBDR

During the 100-year event, replacement of the bridge and the addition of a floodplain bench result in water surface reductions of 1.5 feet at the downstream and upstream faces of the bridge. Flood inundation mapping for the 100-year flood event under the existing and proposed scenarios is depicted on Figures 4-17 and 4-18, respectively. In profile view (Figure 4-19), the flood mitigation benefits from the proposed bridge configuration are far greater when compared to the scenarios where the Bridge Street bridge is removed and if the structure in place were to be replaced with the same kind.

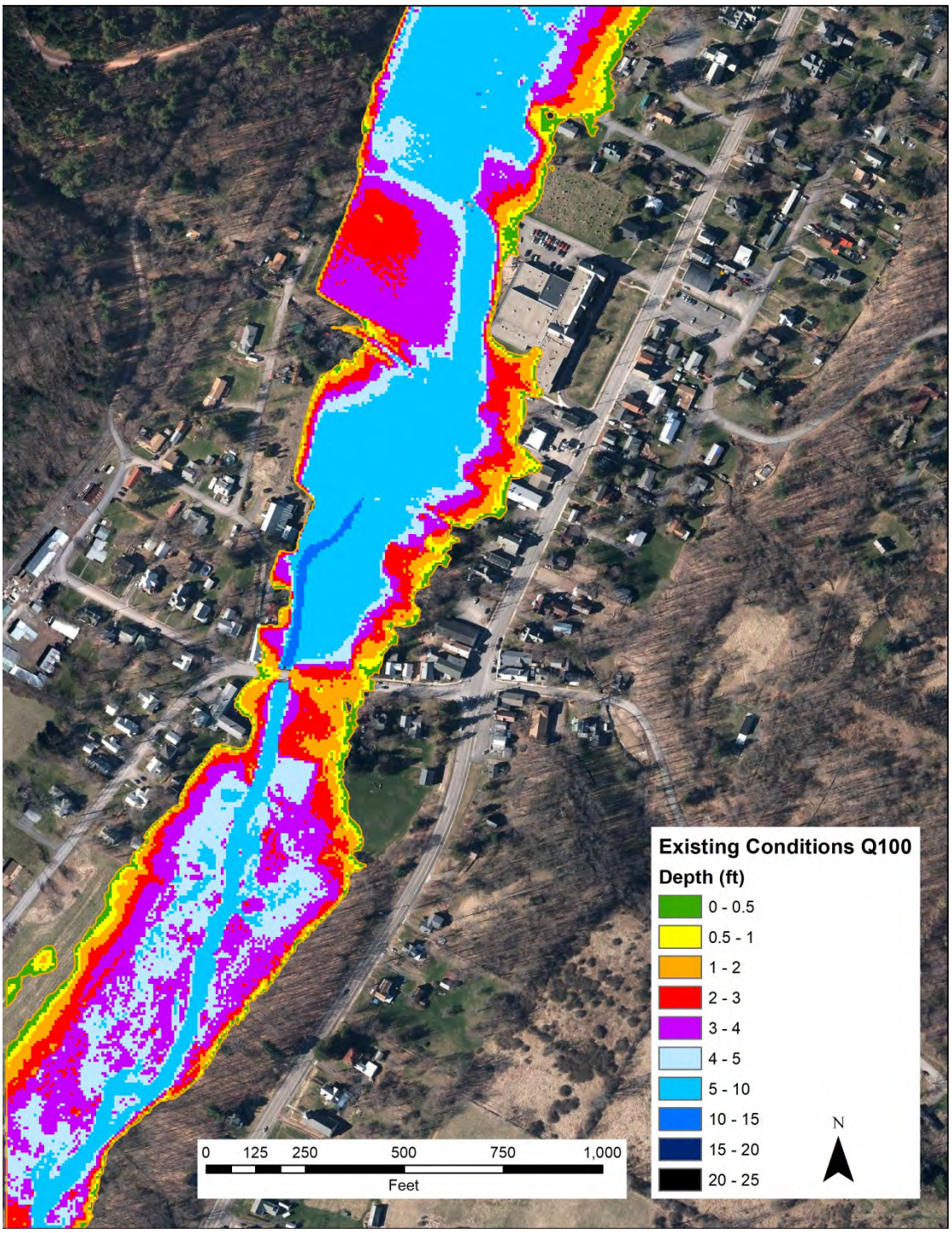


Figure 4-17
Depth Grid Mapping at Bridge Street Bridge – 100-Year Flood
Proposed Conditions

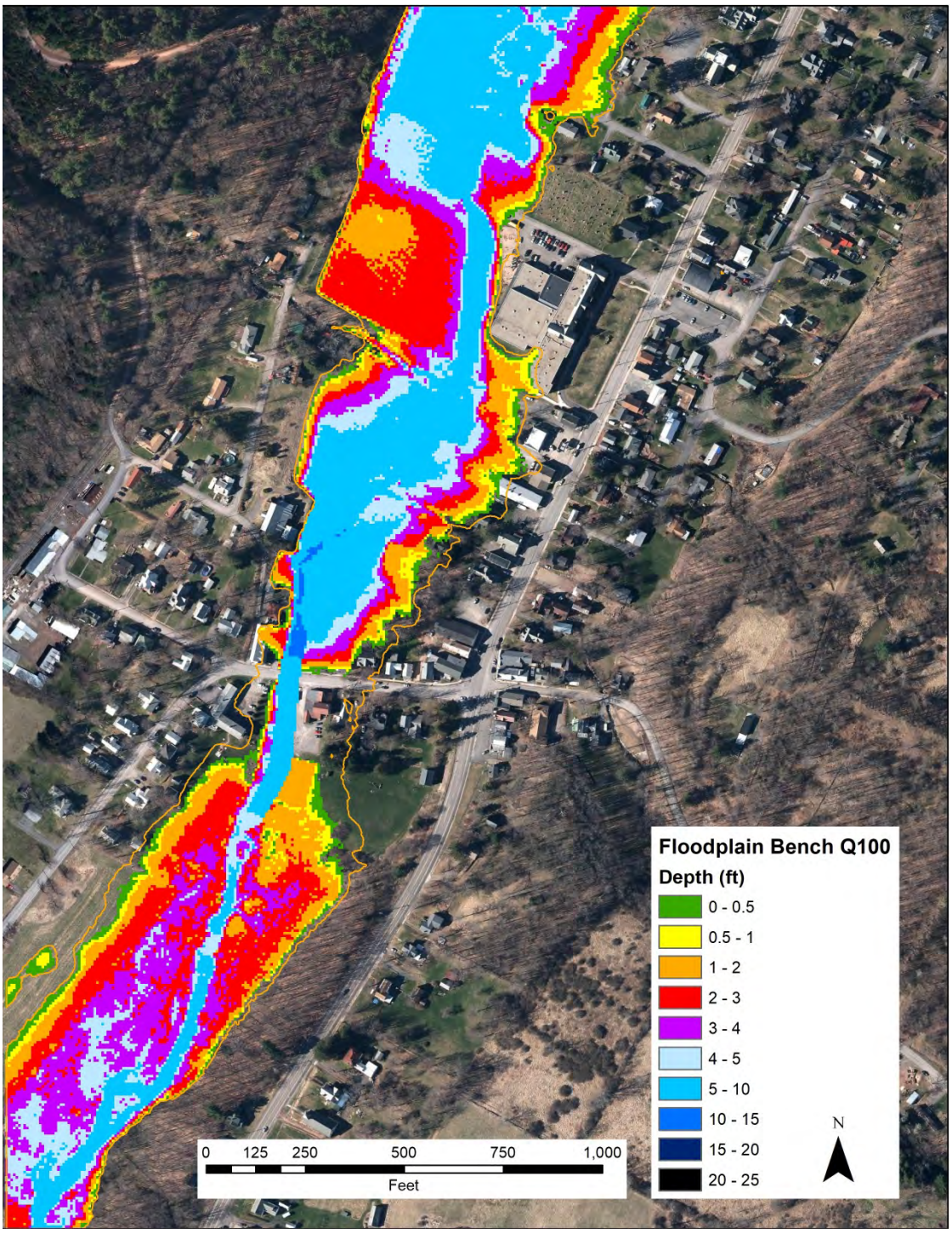


Figure 4-18
Depth Grid Mapping at Bridge Street Bridge – 100-Year Flood
Proposed Conditions

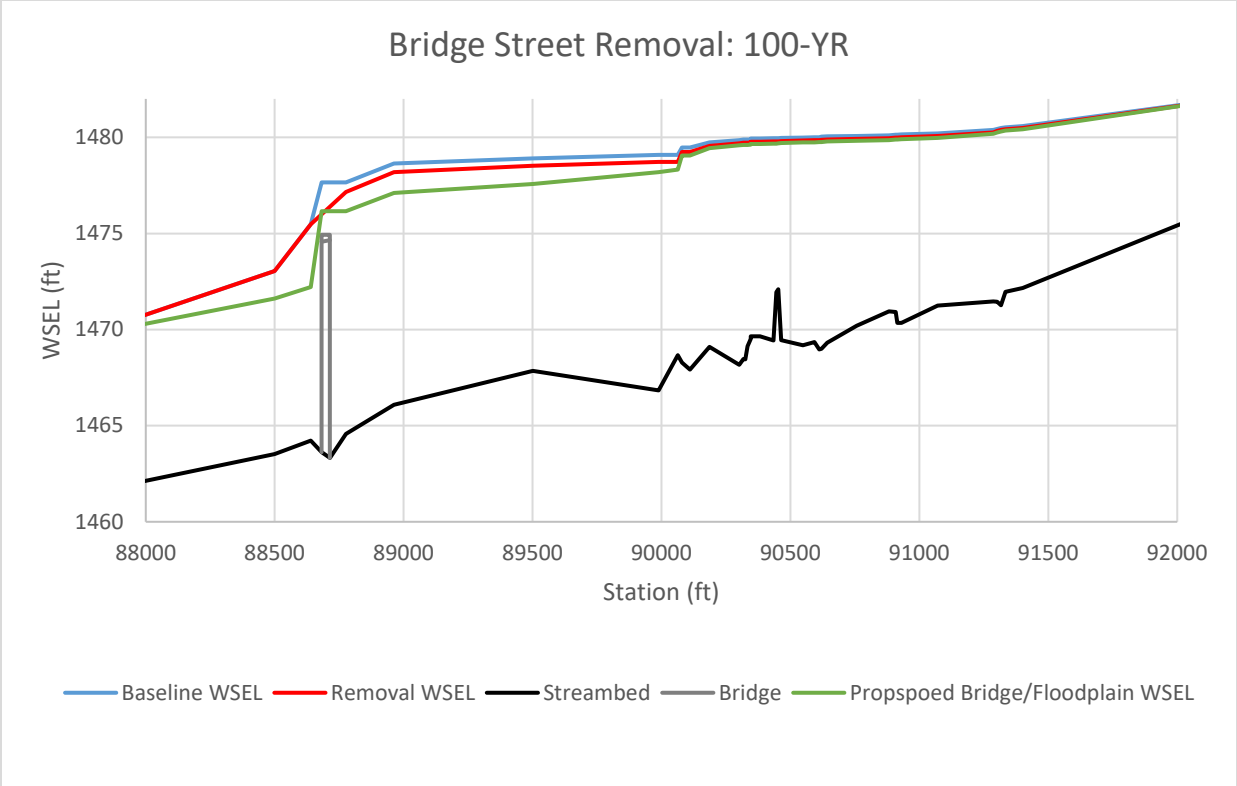


Figure 4-19
Longitudinal Profile – 100-Year Flood
Bridge Street Bridge over EBDR

Recommendations for floodplain enhancement and bridge improvement scenario are discussed further in Section 6.0.

4.4.2 Floodplain Enhancement Scenario 1 Along Bear Kill – Hamlet of Grand Gorge

Scenario 1 considers a floodplain bench enhancement along the right bank of the Bear Kill (Figure 4-20) and aims to alleviate flooding of mobile homes located in Park Lane, which the FAC depicted as a potential area of concern. The property is located off northbound NYS Route 23 below the confluence of Jump Brook with the Bear Kill and is at a low grade in relation to the surrounding terrain. Existing conditions modeling indicates that floodwaters break over the right bank during the 25-year discharge, resulting in flooding of mobile homes. The proposed mitigation scenario would require excavation of the opposite bank in order to allow the floodplain bench to become activated during the 10-year storm. The floodplain configuration that proved to be the most effective called for a 550-foot-long, 100-foot-maximum-width design.

Figure 4-20
Floodplain Bench Enhancement Scenario 1 along Bear Kill, Hamlet of Grand Gorge

Flood inundation mapping for the 10-year flood event under existing conditions is depicted on Figure 4-21. Flood inundation mapping for the 10-year flood event under floodplain enhancement Scenario 1 is depicted on Figure 4-22. Mapping for the 50-year flood event is depicted on Figures 4-23 and 4-24. Mapping for the 100-year flood event is depicted on Figures 4-25 and 4-26.

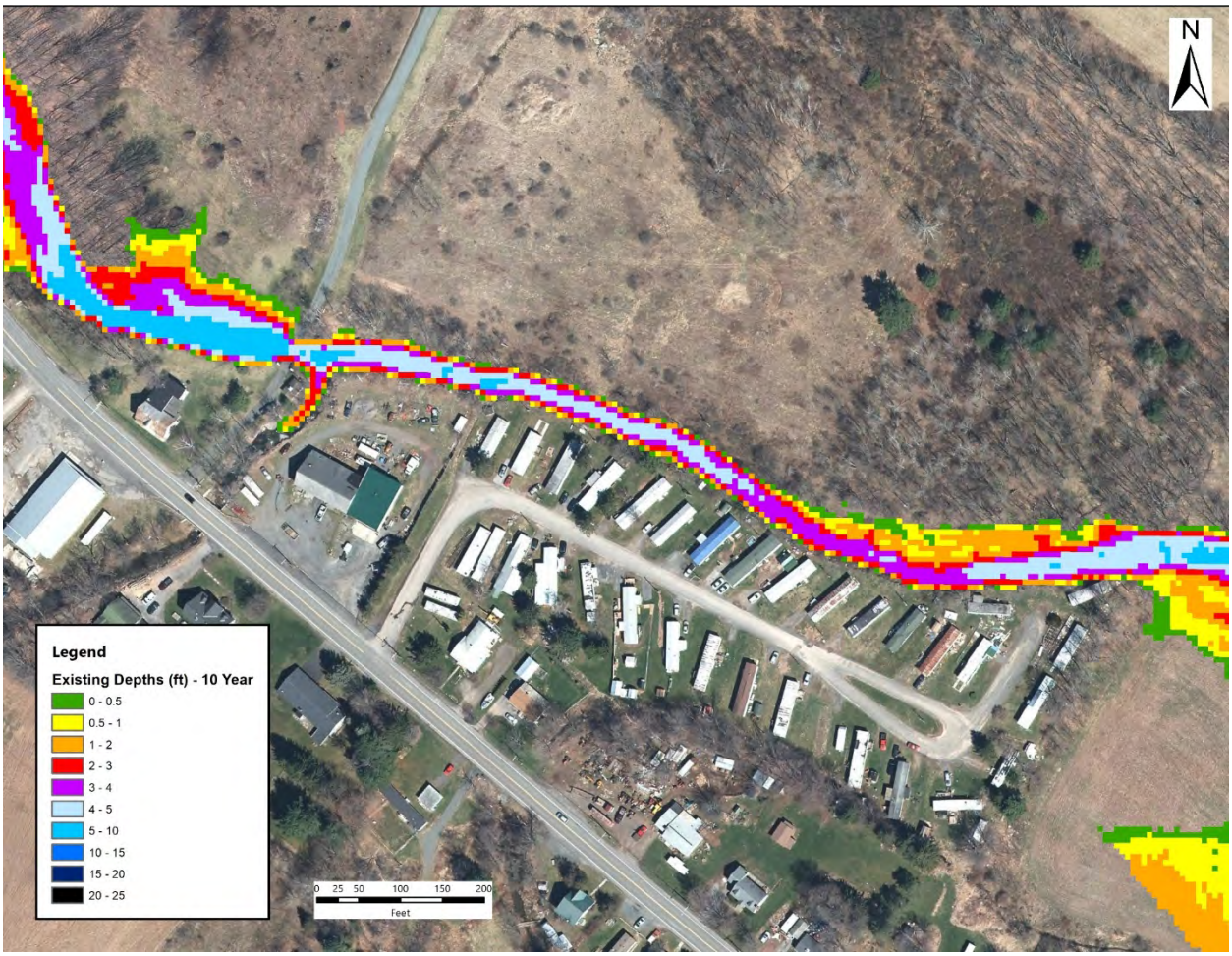


Figure 4-21
Depth Grid Mapping at Park Lane Homes – 10-Year Flood
Existing Conditions

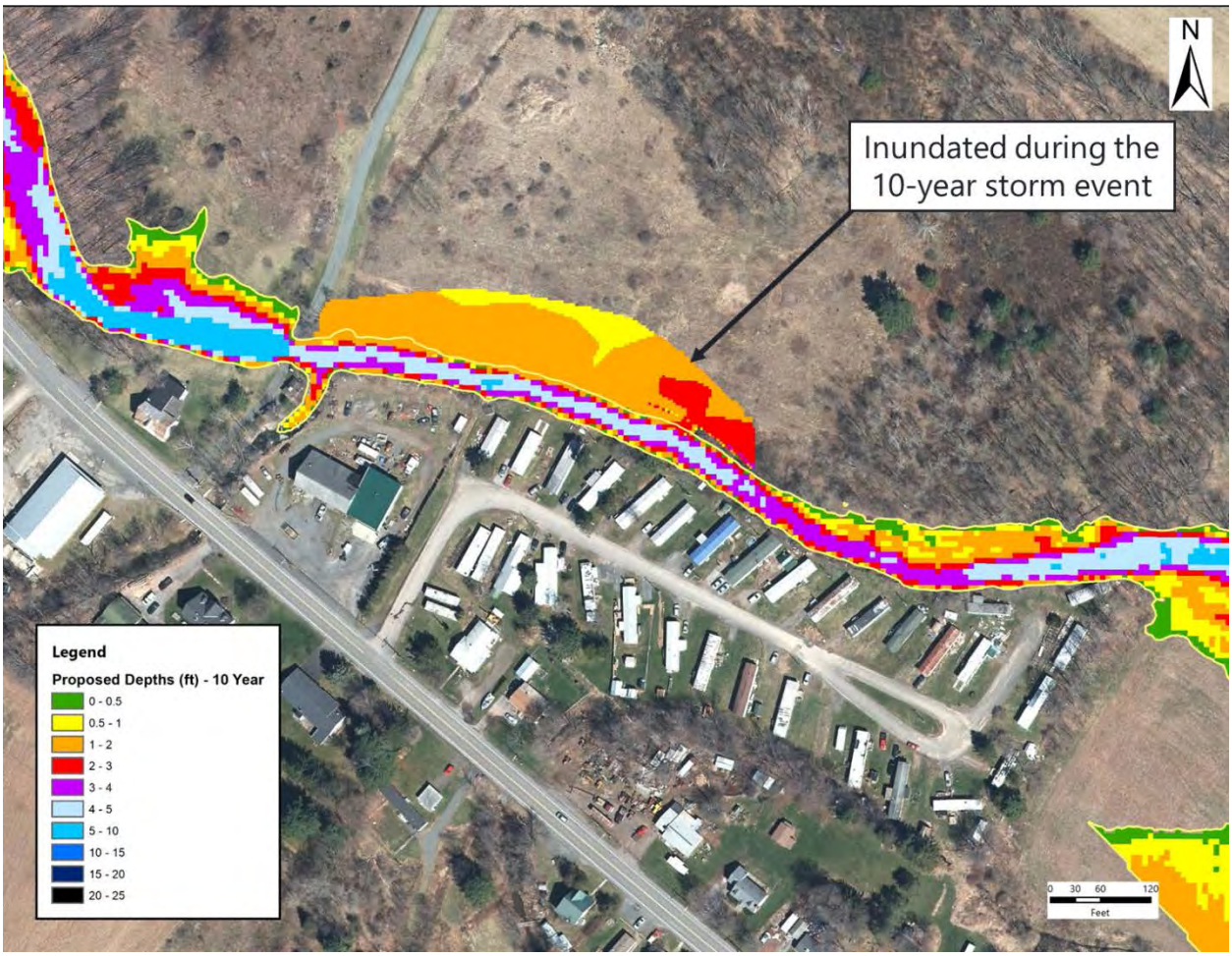


Figure 4-22
Depth Grid Mapping at Park Lane Homes – 10-Year Flood
Proposed Conditions

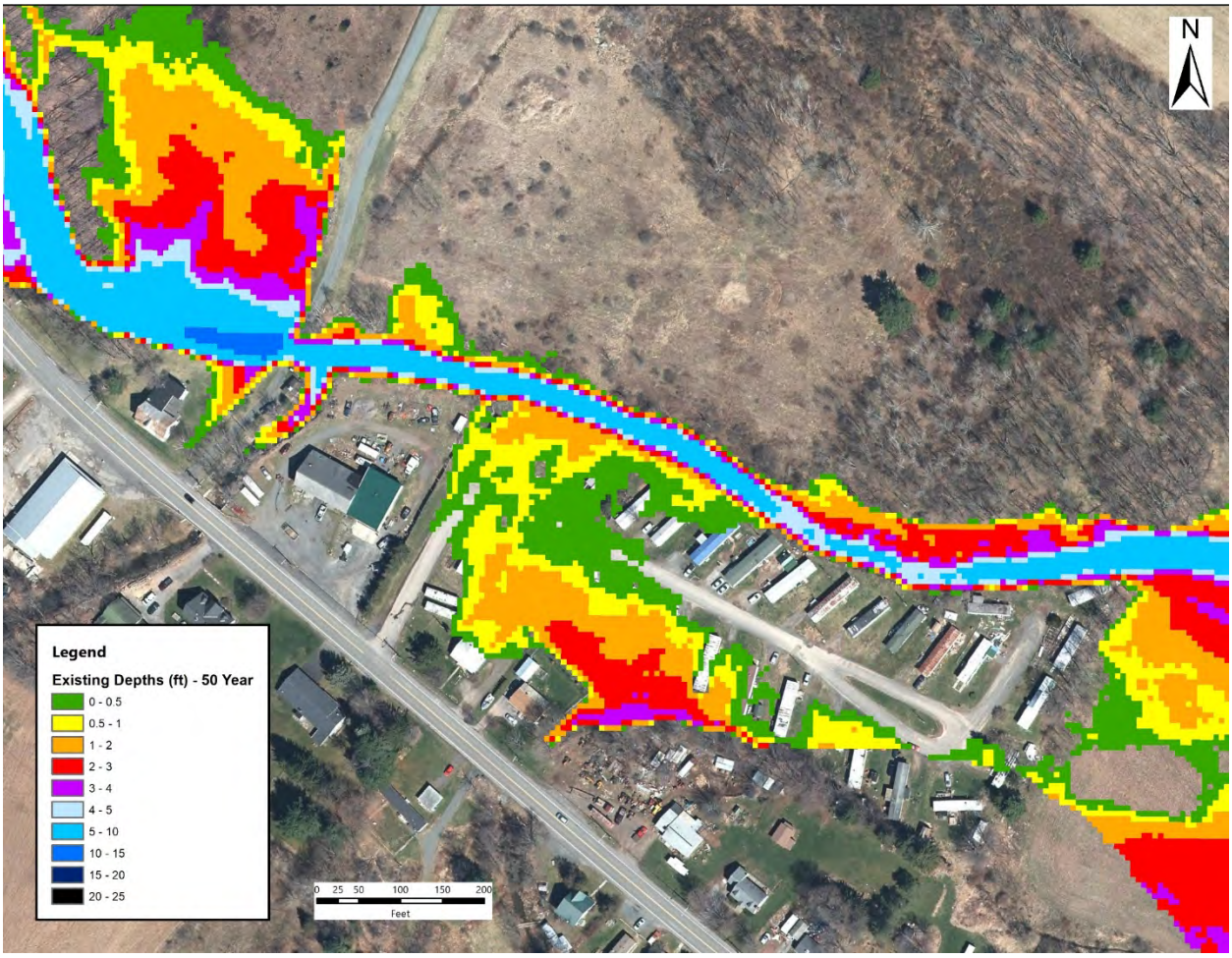


Figure 4-23
Depth Grid Mapping at Park Lane Homes – 50-Year Flood
Existing Conditions

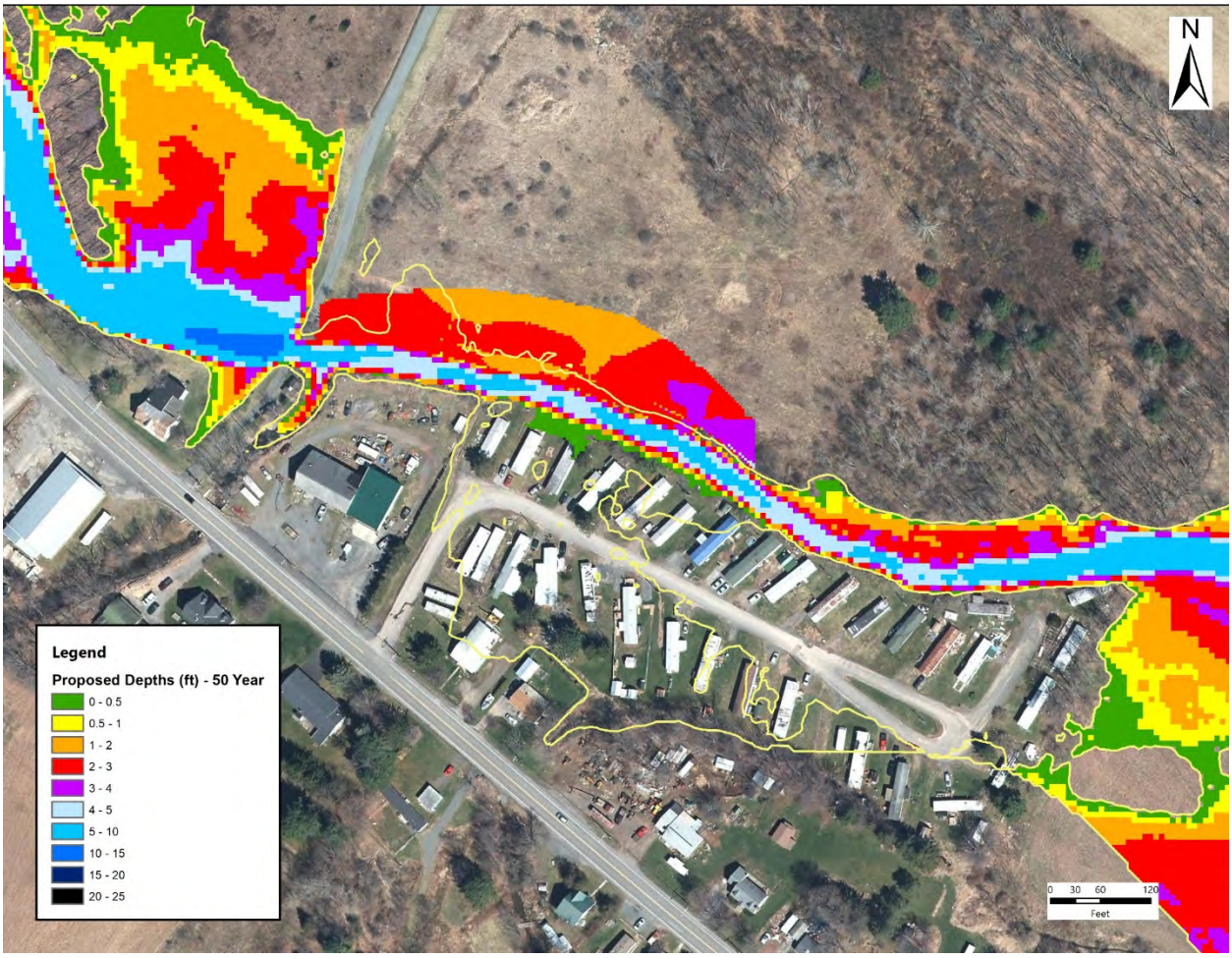


Figure 4-24
Depth Grid Mapping at Park Lane Homes – 50-Year Flood
Proposed Conditions

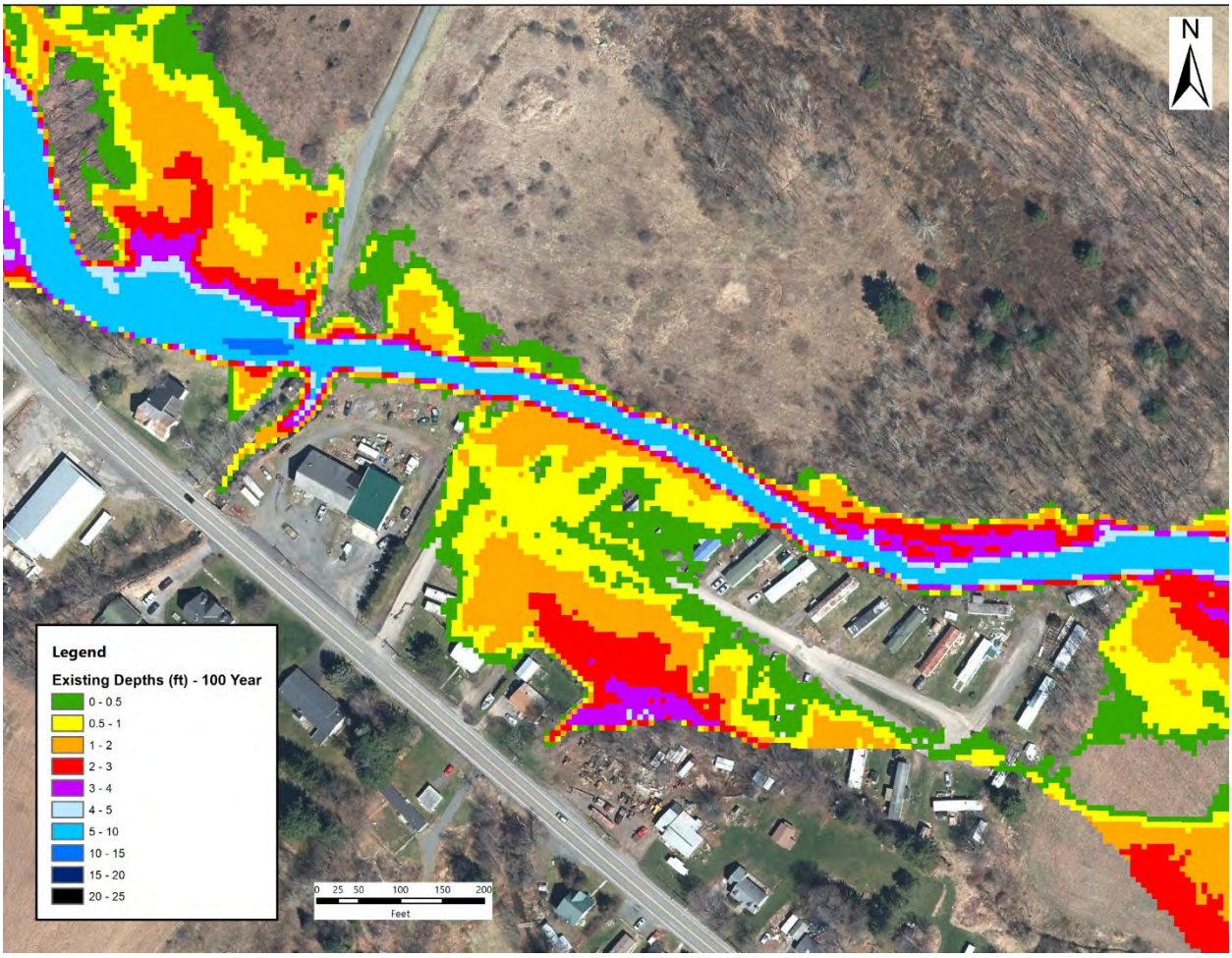


Figure 4-25
Depth Grid Mapping at Park Lane Homes – 100-Year Flood
Existing Conditions

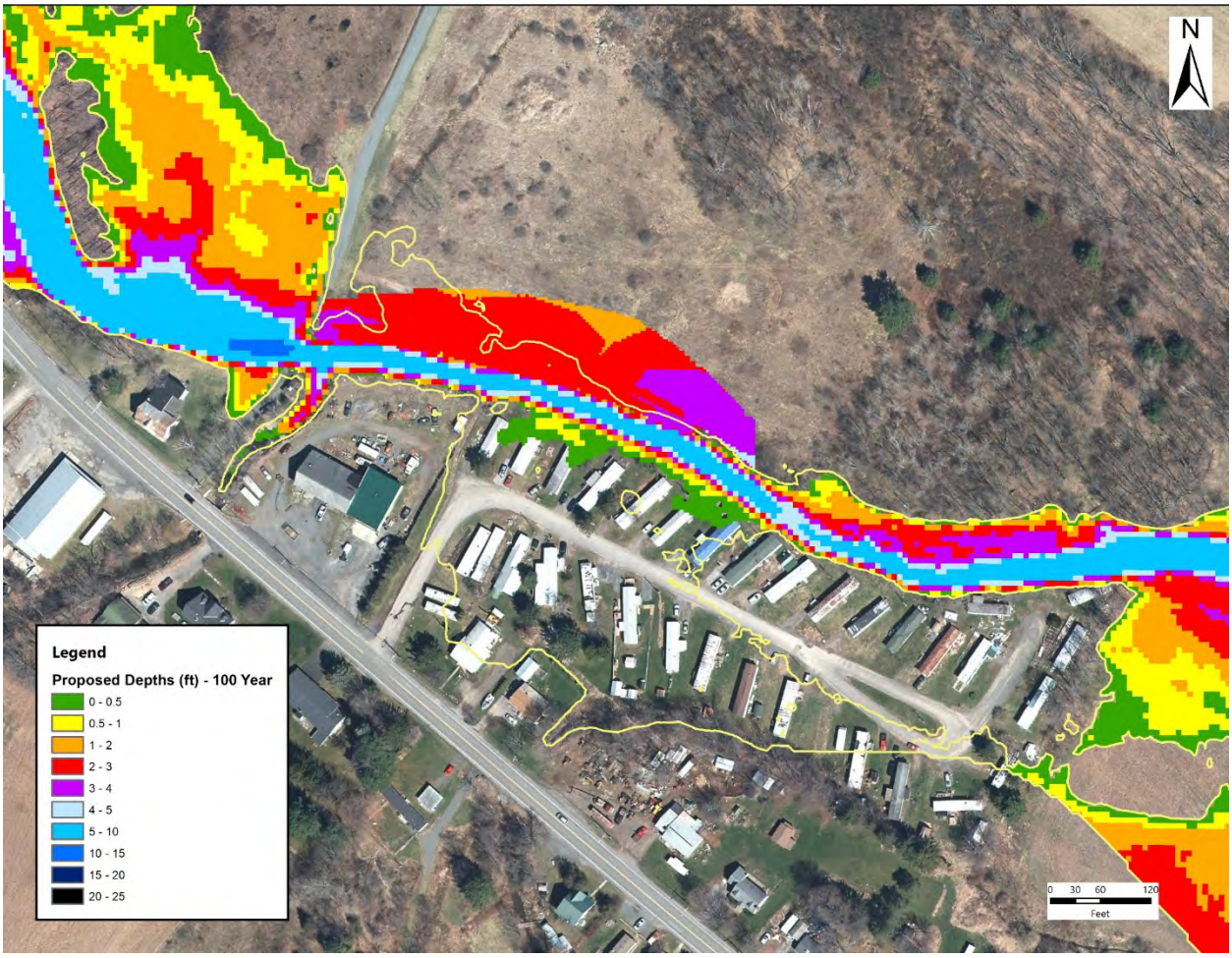


Figure 4-26
Depth Grid Mapping at Park Lane Homes – 100-Year Flood
Proposed Conditions

The proposed floodplain bench was successful at reducing water surface elevations along Park Lane during the 25-, 50-, and 100-year flood events. Recommendations for floodplain enhancement scenarios are discussed in further detail in Section 6.0.

4.4.3 Floodplain Enhancement Scenario 2 along Bear Kill – Hamlet of Grand Gorge

Scenario 2 entails a floodplain bench enhancement along the Bear Kill, approximately 400 feet downstream of the NYS Route 30 bridge, in the backyards of homes and businesses located on NYS Route 23 (Figure 4-27). No report of previous flooding was reported for this location although hydraulic simulations indicate that some of the buildings in the general area would experience flooding as frequent as the 10-year storm event. Under floodplain enhancement Scenario 2, excavation of the left and right floodplains along the Bear Kill would be necessary to optimize flood mitigation benefits. The floodplain layout for this scenario includes a 680-foot-long, 120-foot-maximum-width floodplain on the right bank and a smaller 200-foot-long, 125-foot-maximum-width floodplain on the left bank. Compared to Scenario 1, this alternative has a larger design area footprint and would require removal of existing structures on the floodplain.

Additionally, for this simulation, sections of the Bear Kill main channel were widened to a top width of 42 feet, and the floodplain benches for this alternative were designed to inundate during the 5-year storm. It should be noted that Scenario 2 represents just one of many possible configurations for floodplain benching along this section of the Bear Kill.

Figure 4-27
Floodplain Bench Enhancement Scenario 2 along Bear Kill, Hamlet of Grand Gorge

Hydraulic modeling of Scenario 2 indicates that the enhancement of the floodplain in this area would result in significant water surface elevation reductions, as high as 2.5 feet in some areas during the 10-year flood event (Figure 4-28). During the 50-year flood event, water surface elevation reductions ranged from 0.5 to 3.6 feet and resulted in major inundation extent reductions (Figure 4-29). Under the 100-year flood event, Scenario 2 results in similar water surface elevation reductions as during the 50-year flood event. Inundation mapping for the 100-year storm event is depicted in Figures 4-30 and 4-31.

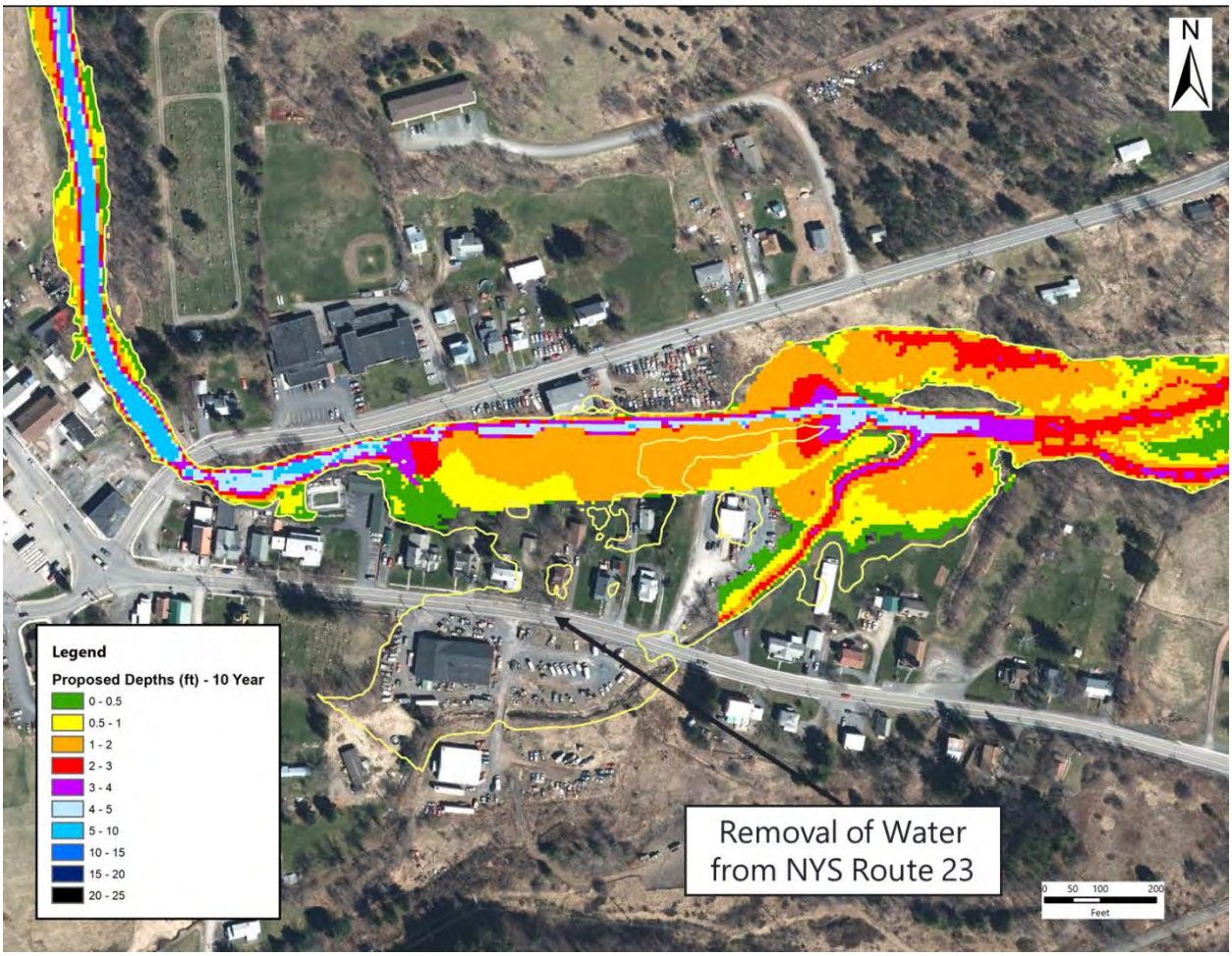


Figure 4-28
Depth Grid Mapping of Floodplain Scenario 2 – 10-Year Flood
Proposed Conditions

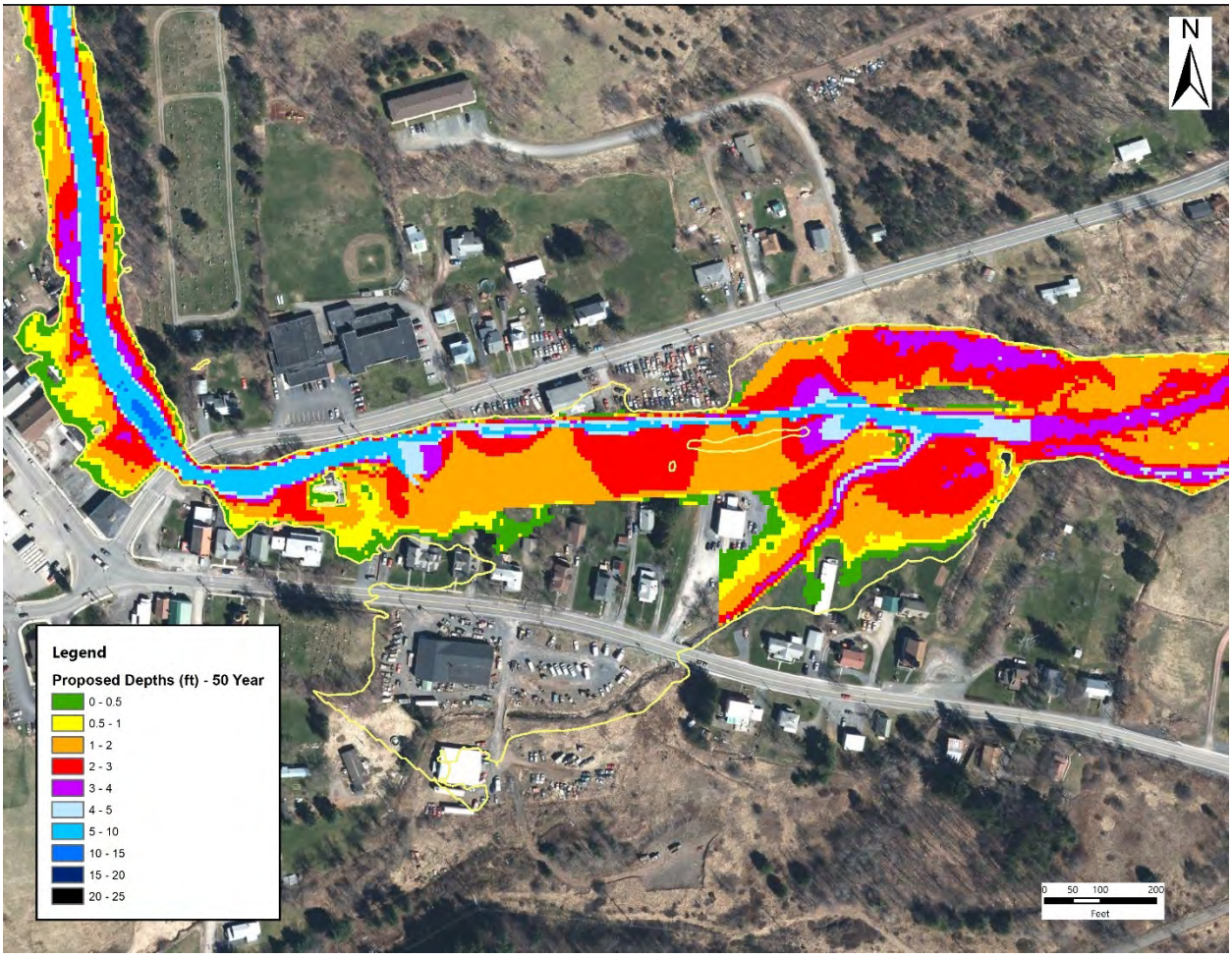


Figure 4-29
Depth Grid Mapping of Floodplain Scenario 2 – 50-Year Flood
Proposed Conditions

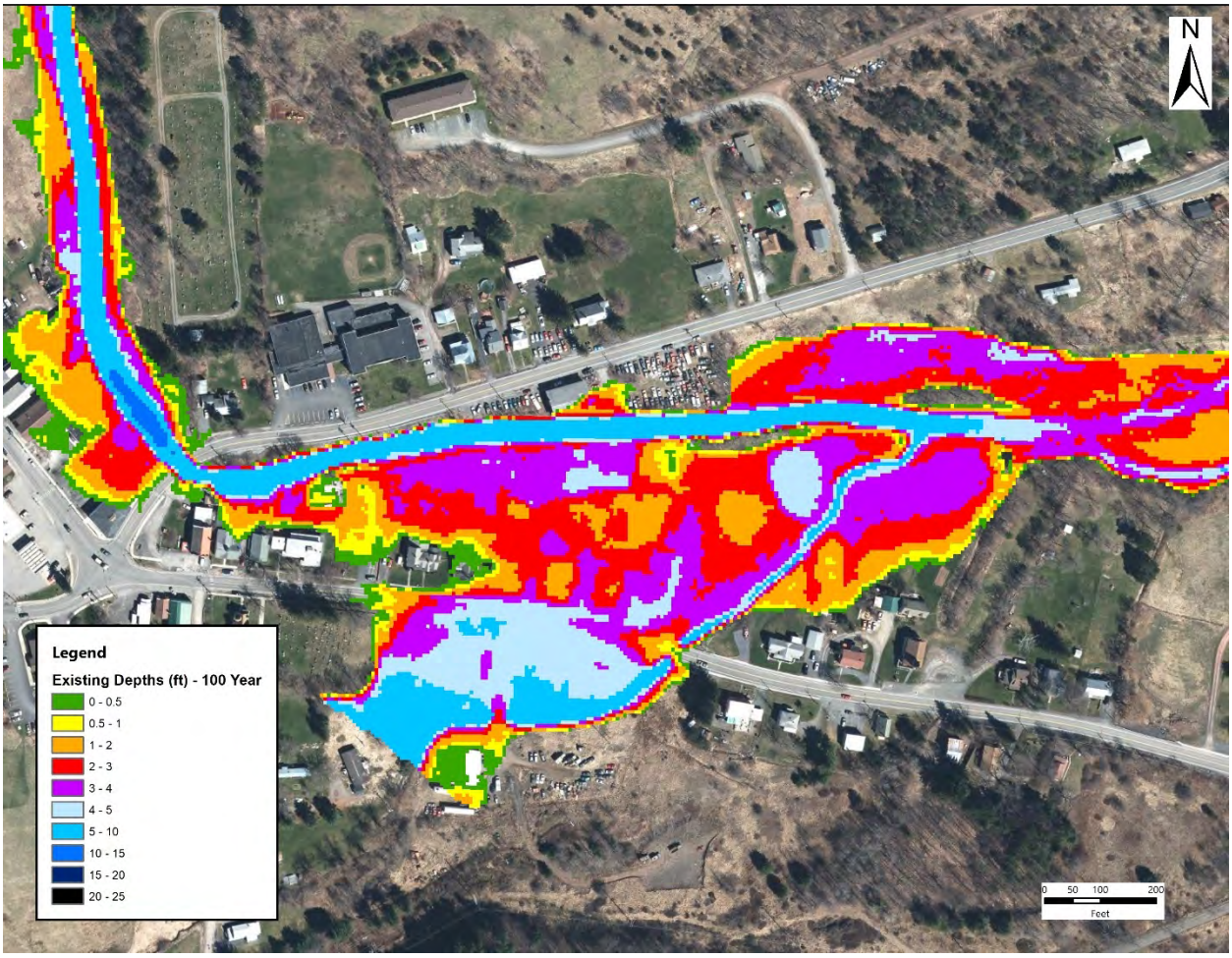


Figure 4-30
Depth Grid Mapping of Floodplain Scenario 2 – 100-Year Flood
Existing Conditions

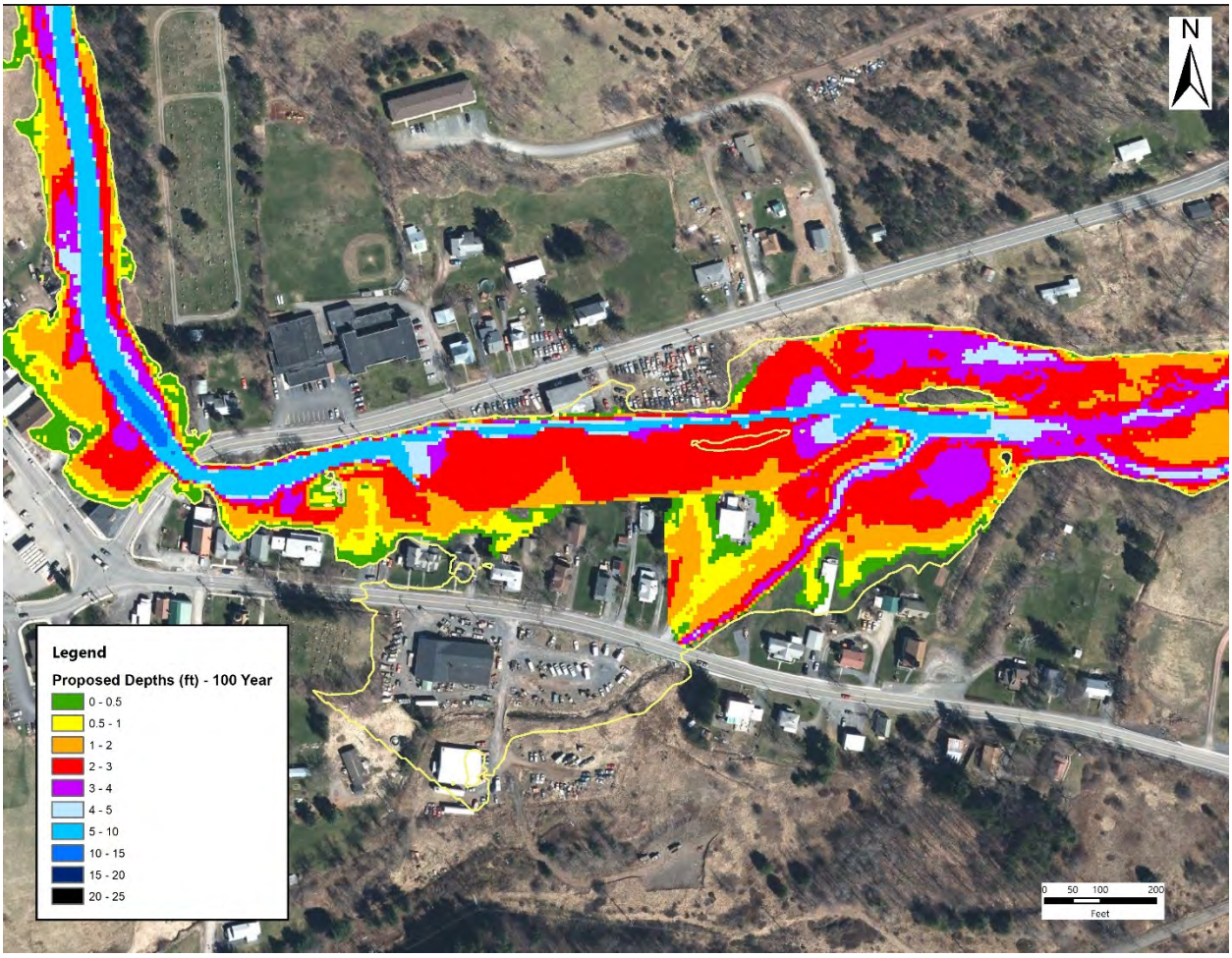


Figure 4-31
Depth Grid Mapping of Floodplain Scenario 2– 100-Year Flood
Proposed Conditions

4.5 Culvert Improvement Assessment

Three culvert crossings were evaluated along Vega Mountain Stream in the hamlet of Roxbury (Figure 4-32). For the two more downstream culverts in the watercourse, a HEC-RAS model was created for the purpose of analysis. Alternatives target minimal alterations of roadway profiles and alignments unless necessary. Analysis for the culvert near where Vega Mountain Road meets Johnson Road was conducted using the FHWA modeling software *HY-8*.

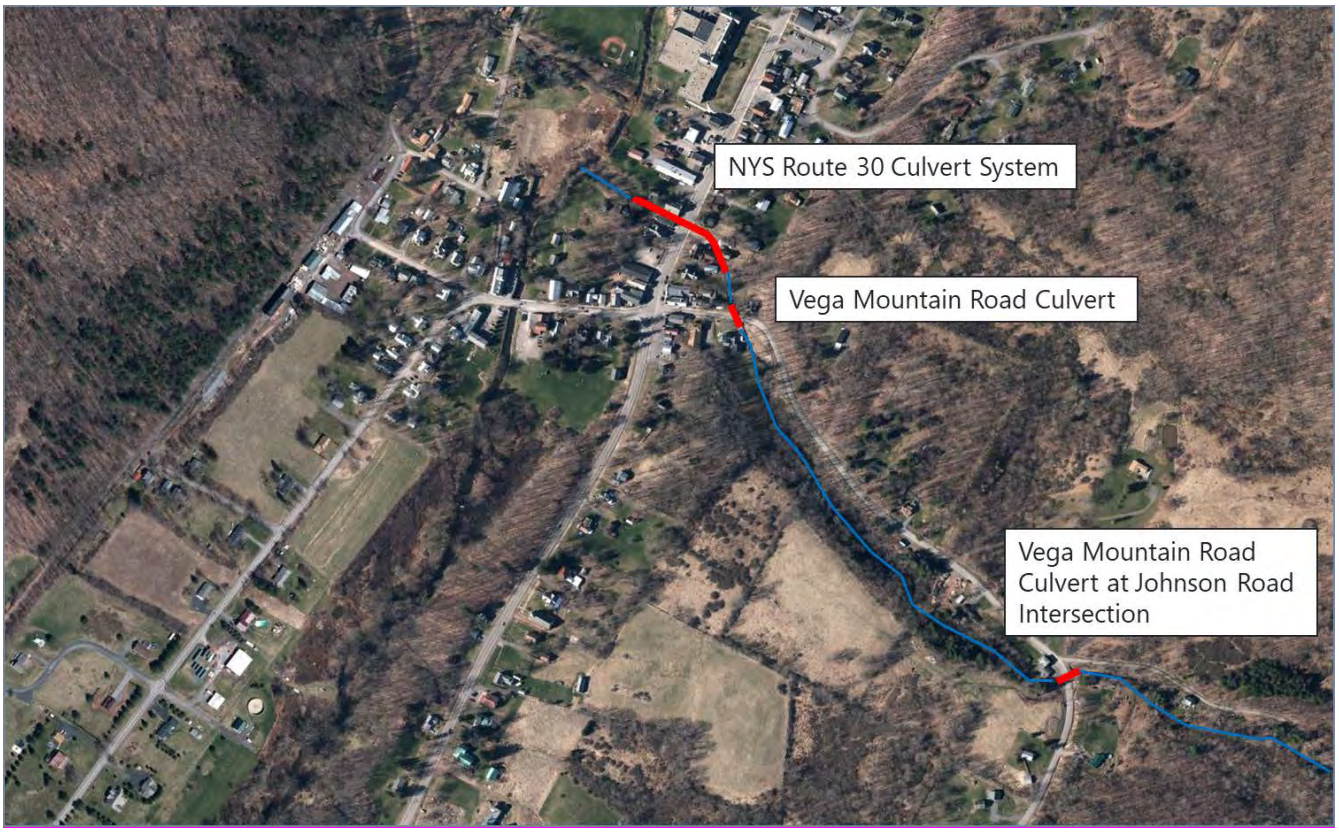


Figure 4-32
Location of Culvert Crossings over Vega Mountain Stream

4.5.1 NYS Route 30 Culvert System

The culvert system that conveys Vega Mountain Stream under Route 30 consists of an approximately 350-foot-long, interconnected system of pipes with a drop structure at its inlet. The drop structure inlet (Figure 4-33) is located behind homes on the east side of Main Street, approximately 180 feet downstream of the Vega Mountain Road crossing. This inlet pipe is a 4-foot-diameter corrugated metal pipe that runs approximately 120 feet, passing under a privately owned parcel on the east side of Main Street that currently has several dilapidated buildings on it. This section of pipe is owned by the Town of Roxbury. The inlet pipe connects to a 54-foot-long, 64-inch by 43-inch corrugated metal pipe arch, which runs under NYS Route 30 and is owned by NYSDOT. The arch pipe flows to a 180-foot-long, 64-inch by 43-inch corrugated outlet pipe, which passes under a driveway between two buildings located along the west side of Main Street before discharging to an open channel that flows to the EBDR (Figure 4-34). The outlet section of pipe is owned by the town.

In past floods, the culvert and channel upstream have been susceptible to debris jams, further limiting the capacity of the structure and allowing floodwater to overtop the structure. On these occasions, floodwaters traveled through the backyards of homes located to the east of NYS Route 30, across NYS Route 30, through the backyards on the west side of NYS Route 30, where they eventually reached the EBDR.

Figure 4-33
Inlet Structure to Pipe Flowing under NYS Route 30, Vega Mountain Stream

Figure 4-34
Outlet Culvert of Pipe System under NYS Route 30

On October 15, 1999, the Town of Roxbury received a letter from NYSDOT regarding drainage in the Vega Mountain/Route 30 area. The analysis considered the hydraulic capacities of the individual structures that carry the Vega Mountain Stream under Vega Mountain Road and NYS Route 30. Below is a summary of key findings from DOT's assessment:

- Regression equations developed by USGS were used to compute peak flows for a 24-hour duration event.
- The inlet pipe to the drainage system can carry approximately a 5-year storm event.
- The middle, NYSDOT-owned pipe under NYS Route 30 can carry approximately a 10-year storm event.
- The outlet pipe can carry approximately a 25-year storm event.
- The sections of channel immediately downstream and upstream of the Vega Mountain Road culverts have no storage capacity for any debris, and it all gets washed into the drainage system under Route 30, further limiting the capacity of the pipe network.

This system of culverts was also identified as undersized and incapable of conveying the suggested design storm in the 2006 Stormwater Infrastructure Assessment Report conducted by RETTEW Engineering and Surveying, LLC.

MMI's hydraulic analysis for this LFA shows results similar to those of NYSDOT although the hydrology used in MMI's analysis used more up-to-date information. Based on the MMI analysis, the culvert system is only able to safely convey the 1-year storm. The series of culverts is severely undersized and will continue to be an issue for current and future climactic conditions. Hydraulic analysis indicates that a 16-foot-wide by 4-foot-high box culvert under NYS Route 30 would convey the 50-year storm event. Our recommendation is that the culvert under NYS Route 30 be replaced and that the inlet and outlet pipes be removed and the sections of channel daylighted. This proposed scenario is discussed in more detail in Section 4.5.4 and in the recommendations in Section 6.0 of this report.

4.5.2 Vega Mountain Road Culvert

The structure under Vega Mountain Road is a 4-foot-diameter, 30-foot-long smooth metal pipe. Upstream and downstream of the culvert are very steep sections of channel that are lined with placed heavy stone (Figure 4-35). This area has been pointed out as a major contributor to flooding for the hamlet of Roxbury. During storm events, the culvert and the channel are both unable to convey the volume of water coming from the watershed, causing floodwaters to run directly down Vega Mountain Road, across NYS Route 30, and down Bridge Street until reaching the EBDR. In 2011 during Tropical Storm Irene, floodwaters broke out of the channel causing severe flooding of homes and businesses along Vega Mountain Road (Figures 4-36 and 4-37).

Figure 4-35
Culvert Carrying Vega Mountain Road (Looking Downstream)

Figure 4-36
Floodwaters from Vega Mountain Stream Flowing Through a Building that is Located on the Northern Corner of the Vega Mountain Road /NYS Route 30 Intersection

Figure 4-37
Floodwaters from Vega Mountain Stream Flowing Down Vega Mountain Road During Tropical Storm Irene

The present culvert is only able to fully convey the 1-year discharge; all greater discharges lead to overtopping of the roadway. The hydraulic capacity is also very sensitive to debris blockage, making the culvert incapable of conveying the 1-year storm event if at least 30 percent of the hydraulic opening becomes obstructed. Assessment of the structure indicates that in order to pass the 50-year flood the structure would need to be replaced with a 14-foot-span, 5-foot-rise box culvert. Furthermore, the capacity of the upstream channel would need to be increased in order to gain the most from increasing the size of the culvert. In its current configuration, the channel upstream of the culvert does not have the capacity to contain the 10-year storm. Recommendations for this area are discussed in more detail in Section 4.5.4 of this report as well as in Section 6.0.

4.5.3 Vega Mountain Culvert at Johnson Road Intersection

The existing structure (Figure 4-38) is a circular, 4-foot-diameter dual-wall plastic corrugated pipe. This culvert has a stacked concrete block headwall and a perched outlet and is mostly clear of any sediment due to the high velocities it experiences. This structure has reportedly washed out several times in the past, including during a recent flood in 2018.

In its current configuration, this crossing has a capacity of approximately 172 cfs, which will pass the 1-year flood but is overtopped at any greater flow. Initial hydraulic modeling indicates that a 12-foot-span, 5-foot-rise box culvert would pass the 50-year flood.

Figure 4-38
Inlet of the Johnson Road Culvert carrying Vega Mountain Stream

4.5.4 Assessment of Culvert Improvements and Daylighting – Vega Mountain Stream

Given the severity of flooding that is caused by the undersized culvert and channel that convey Vega Mountain Steam, long-term alternatives were considered to lessen the frequency of flooding of residential and commercial buildings along Vega Mountain Road, NYS Route 30, and Bridge Street. One potential solution is displayed graphically in Figure 4-39 and would entail the following sequence of actions, which should progress from downstream to upstream:

- Daylighting of the pipe system upstream and downstream of the NYS Route 30 crossing. Figure 4-39 illustrates the proposed limits of stream daylighting.

- Installation of a replacement culvert under NYS Route 30 with a 16-foot-span, 5-foot-rise box culvert to convey the 50-year storm
- Replacement of the culvert crossing under Vega Mountain Road with a 16-foot-span, 4-foot-rise box culvert
- Increasing the capacity of the channel reach immediately upstream and downstream of Vega Mountain Road. A multistage compound channel is recommended that includes a properly sized low-flow channel, a main bankfull channel, and floodplain. Due to the historic nature of the channel in this area, care would need to be taken during the design process to ensure that historic and aesthetic components of the existing channel are preserved and maintained.

Figure 4-39
Conceptual Alignment of Vega Mountain Stream and Culvert Improvements

During public meetings, a suggestion of allowing and encouraging floodwaters to flow down Vega Mountain Road during severe storms was raised. In this case, rather than improving the existing structures, the town would instead implement other measures, such as higher curbs and repaving of the roadway, in such a way as to ensure that floodwaters coming from Vega Mountain Road are transported more directly to the EBDR. MMI developed a preliminary HEC-RAS 2-dimensional model to understand the magnitude of velocities traveling down Vega

Mountain Road during serve storms. The hydrograph for a 24-hour, 100-year storm event was used for this analysis, and the results indicate that at the peak of the storm, flow velocities down Vega Mountain Road toward Main Street could reach up to 20 feet per second. Flow velocities of this magnitude would be very destructive and threaten public safety if permitted, especially when considering that Main Street is an important thoroughfare in Roxbury. For this very reason, intentionally directing flood flows through the streets is not a viable solution and is not recommended in this report. As a short-term solution, individual floodproofing of structures affected by Vega Mountain Stream is recommended for interim flood relief. Recommendations are further discussed in Section 6.0 of this report.

4.6 Kirkside Park Assessment

MMI conducted field reconnaissance of the Pleasant Valley tributary/EBDR confluence area to investigate flooding of Kirkside Park (Figure 4-40). Site reconnaissance indicated substantial sediment aggradation in the area where Pleasant Valley Brook enters the broad valley of the EBDR. At the confluence, deposits from the brook have formed a multichannel alluvial fan that disperses the stream toward either the EBDR or Kirkside Park. It is recommended that the town pursue suitable means to redirect flow to help reduce, but not eliminate, flooding of nearby fields. At the time of this report, DCSWCD has begun assisting FAC members with permitting measures necessary to mitigate the issue. Recommendations are further discussed in Section 6.0 of this report.

Figure 4-40
Water Ponded at Kirkside Park during a Sunny Day, Summer 2019

5.0 EVALUATION OF PROJECT COSTS

Project cost is an important consideration when planning and prioritizing the implementation of flood mitigation strategies. Cost opinions for implementation of various projects are summarized below. Cost opinion calculations are included in Appendix B.

5.1 Vega Mountain Stream

The watercourse is an unmapped stream by FEMA, and there is no hydraulic model to indicate water surface elevations. Therefore, a benefit-cost analysis (BCA) cannot be conducted using the typical methods. The recommended improvements of the culverts and channel along Vega Mountain Stream will be quite costly. Culvert replacements of the sizes recommended here cost in the range of $400,000 to over $1M each, depending on size, locations of utilities, design and permitting costs, need for landowner easements, and other factors. Similarly, daylighting sections of channel as suggested can be complicated by property easement agreements and location of underground utilities, which will have a significant influence on the design execution and the final project cost. Table 5-1 summarizes the recommendations for Vega Mountain Stream and includes an approximate cost opinion for each condition.

TABLE 5-1
Vega Mountain Stream Crossing Types and Replacement Costs
(Presented as Estimates Only)

Crossing Location	Vega Mountain Road at Johnson Road Intersection	Vega Mountain Road	NYS Route 30
Existing Conditions Description	4.0-foot dual-walled high density polyethylene (HDPE) pipe	4.0-foot smooth steel pipe	Culverts and stormwater catch basins linked in series that extend for over 300 linear feet; inlet pipe is a 4.0-foot corrugated metal pipe.
Recommendation Description	Replace with 12.0-foot-span x 5.0-foot-rise concrete box; square edge with wingwalls	Replace with14.0-foot-span x 5.0-foot-rise concrete box; square edge with wingwalls. Enlarge sections of channel near the culvert.	Daylight stream plus install 16.0-foot-span x 4.0-foot-rise concrete box, square edge with wingwalls, under NY-30 roadway.
Estimated Replacement Structure Cost	$450,000 - $550,000	$350,000 - $400,000	$750,000 - $850,000
Estimated Daylight Cost	N/A	N/A	$400,000
Uncertainties which may Affect Cost	Structure size, utilities	Structure size, utilities	Property acquisitions, underground utilities, final daylighted stream alignment

The town is encouraged to pursue multiple funding sources, including the ones recommended in Section 7.0, and to work closely with Delaware County Department of Public Works (DPW), DCSWCD, NYCDEP, CWC, and NYSDOT to identify and secure funding to implement

improvements. The project should begin with a feasibility study to gain a better understanding of project scope and cost, followed by engineering design, followed by construction of the various components moving from downstream to upstream. Each of these steps can be funded independently, setting the stage for the next step.

5.2 Bridge Street Bridge Replacement and Floodplain Bench Enhancement

Upgrading the Bridge Street bridge to have a larger span and incorporating a floodplain bench along the left bank under the structure optimize benefits by potentially reducing flooding at approximately five buildings located on the western side of NY-30. It is estimated that a replacement structure would amount to anywhere from $3,500,000 to $5,000,000 for design, permitting, and construction. The final cost amount will be highly conditional upon the structure type and any challenges that may arise due to the town water line and possibly other utilities that are located beneath the bridge. The floodplain bench reclamation portion of the channel would be an additional cost ranging from $200,000 to $250,000 for design, construction, and restoration.

5.3 Park Lane Floodplain Bench Enhancement Scenario 1

The scenario evaluated at Park Lane may reduce flood extents enough that the trailer homes would no longer be prone to flooding. By looking at 2016 areal imagery, it was estimated that about 18 trailer homes would benefit from the proposed flood extent reductions from the added floodplain bench. Although it is unclear whether all the mobile homes are currently inhabited, this is a factor that would greatly impact the actual benefit of implementing this project.

It is estimated that the floodplain bench restoration would require approximately 9,500 cubic yards of excavated material to be exported off site. With the addition of other cost considerations such as tree clearing and site restoration, it is estimated that the final project cost could range from $500,000 to $600,000.

5.4 Grand Gorge Floodplain Bench Enhancement Scenario 2

The Grand Gorge floodplain bench scenario, located behind homes and businesses along the Bear Kill, was evaluated. It is estimated that the cost for design and construction of this floodplain bench would range from $550,000 to $650,000. Property acquisition or easement costs are not included in this estimate.

5.5 Other Homes and Properties

For homes in the SFHA, FEMA has developed precalculated benefits for acquisition and elevation of buildings. The following is excerpted from a FEMA memorandum regarding Hazard Mitigation Assistance (HMA) precalculated benefits (FEMA, 2013):

> *FEMA's Risk Reduction Division analyzed over 11,000 structures acquired or elevated and found that the average benefits for each project type are $276,000 and $175,000 respectively. Therefore, FEMA has determined that the acquisition or elevation of a structure located in the 100-year floodplain as delineated on the Flood Insurance Rate Map (FIRM) or based on best available data, that costs less than or equal to the amount of benefits listed above is considered cost effective. For projects that contain multiple*

structures, the average cost of all structures in the project must meet the stated criterion. This methodology is available for all Hazard Mitigation Assistance (HMA) grant programs.

This dramatically simplifies the BCA process for homeowners in the SFHA floodplain if relocation or elevation costs are projected to be less than these average benefit values. It is recommended that Roxbury residents currently within the FEMA SFHA along the EBDR seek consultation on a case-by-case basis to strategize flood mitigation alternatives best suitable for their situation.

Several properties along the Vega Mountain Road/NYS Route 30/Bridge Street corridor experience repetitive flood damage from floodwaters originating from Vega Mountain Stream (Figure 5-1). Vega Mountain Stream is an unmapped watercourse with no designated FEMA SFHA, and therefore, home and business owners are unable to take advantage of the precalculated benefits described above.

The cost of elevating and floodproofing structures can be highly variable depending on the age, size, condition, and foundation type of a home or business. For buildings along Vega Mountain Road, Main Street, and Bridge Street, the cost of elevating a building might range from as low as $40,000 for a single-family home with a small footprint to as high as $600,000 for a large building.

If desired, affected property owners can request individual feasibility studies for relocating or floodproofing their structure. It is worth noting that the cost for floodproofing individual structures is highly variable and contingent upon several factors, some of which include the structure's condition, complexity, and building footprint size. Additionally, it would be in the town's best interest to encourage the implementation of long-term solutions to flooding along Vega Mountain Road rather than seeking to individually floodproof structures and allow flooding from Vega Mountain to persist. Assistance programs and potential funding sources are described in Section 7.0 of this report.

For the hamlet of Grand Gorge, provided that the Bear Kill is a mapped watercourse by FEMA, property owners located within the designated Zone A are eligible to use the best available data to determine if residents qualify for precalculated benefits.

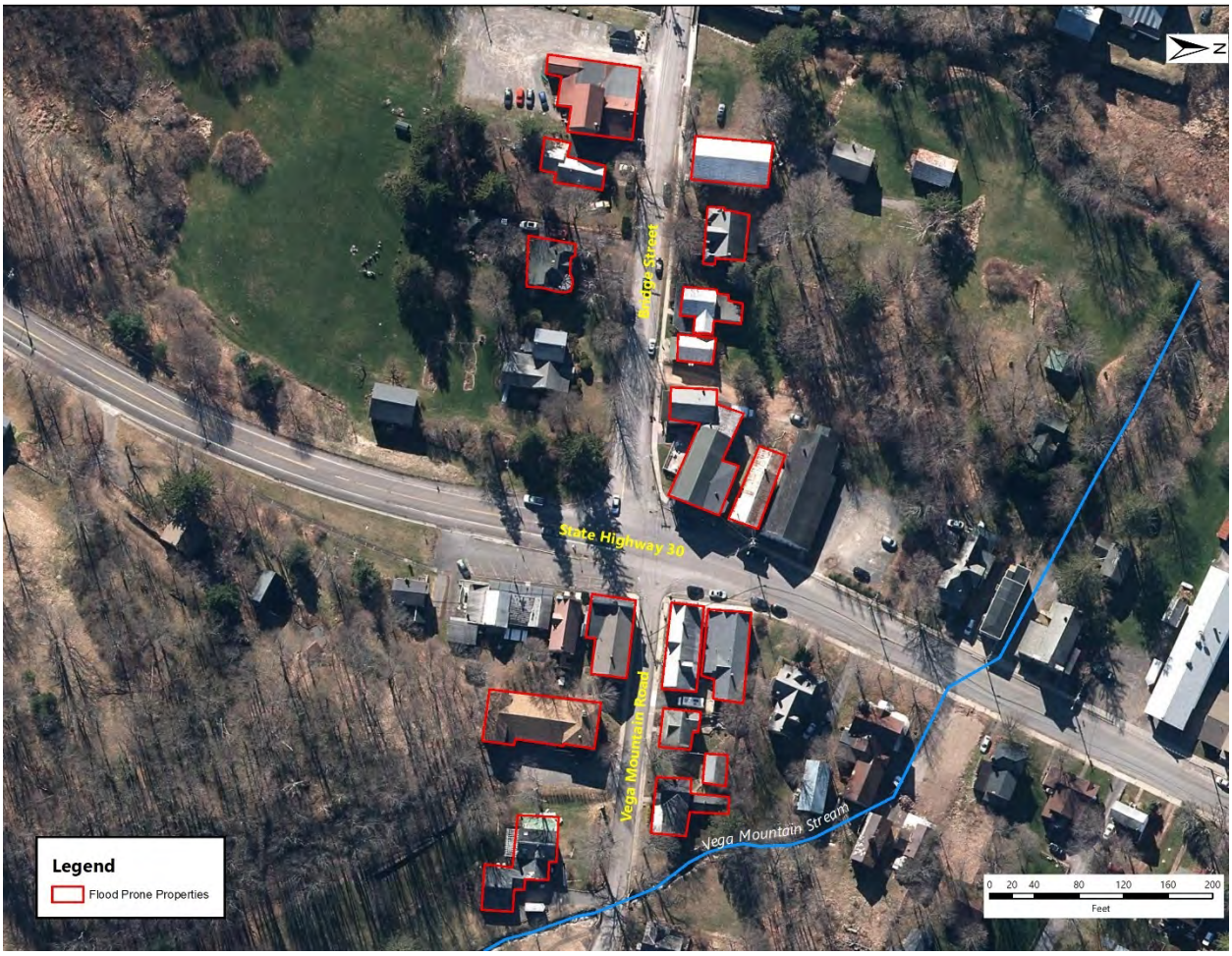


Figure 5-1
Structures (Highlighted Red) Described during Public Meetings as Experiencing Recurring Flood Damage from Vega Mountain Stream

6.0 FINDINGS AND RECOMMENDATIONS

6.1 Hamlet of Roxbury

6.1.1 Culverts

Overall, assessed culverts are not adequately sized in that they do not meet all NYSDOT standards and NYSDEC guidelines for new culverts in terms of hydraulic opening, permissible headwater depths, and/or aquatic organism passage. Flood resiliency may be improved if undersized culverts have been identified and replacement structures adequately sized, even if only approximately, before damage occurs. Regular culvert inspections and an up-to-date asset inventory may help to prioritize culverts for scheduled replacement and prepare for appropriate repairs in case of flooding damage.

Minimizing additional risk in the event of culvert failure is a key component of upgrade prioritization. A collapsed culvert may pose an immediate danger to those nearby, but the loss of a critical link in the road network can have further-reaching consequences. The following recommendations are offered.

Vega Mountain Stream at Vega Mountain Road and NYS Route 30:

- Vega Mountain Stream is a persistent flood source for the hamlet of Roxbury. Hydraulic analysis determined that the series of culverts and the stream channel do not have the hydraulic capacity to convey the large volume of water coming from its basin.
- The proposed long-term solution, executed from downstream to upstream, would entail daylighting the section of stream that is east and west of Route 30, installing a new culvert under Route 30, enlarging the existing stream channel to capacity, and replacing the culvert under Vega Mountain Road.
- Proposed short-term solutions include individual floodproofing of structures affected by Vega Mountain Stream; this would provide interim flood relief.
- It is recommended that the town first seek funds to have the recommended daylighting and culvert replacements fully designed. This way, the project will be far advanced in engineering design and "shovel ready" for the next round of available funds; construction could begin within a short time.
- It is recommended that a full hydraulic assessment be conducted to ensure that the new culverts meet NYSDOT design criteria.

Vega Mountain Stream at Johnson Hollow Road:

- This culvert was found to be severely undersized, only able to convey the volume of a 1-year storm event before overtopping.
- It is recommended that the existing culvert be replaced with a new culvert sized to pass the 50-year flow and adhering to NYSDOT standards.
- Initial modeling indicates that a 16-foot x 4-foot concrete box culvert will be required.
- A full hydraulic analysis is recommended.

6.1.2 Bridges

Hydraulic assessment of the five bridges in the LFA project areas indicated that none of the structures is properly sized to meet NYSDOT design standards. Although not mandated by the town, it is advised to consider the guidelines established by NYSDOT for new bridges. Replacing these bridges to meet these criteria represents a substantial capital investment, so upgrades must be prioritized in order to maintain a robust transportation network and efficiently improve flood resiliency.

Structures that carry vital transportation routes are essential for safe passage of residents who may need to evacuate or obtain supplies, for emergency responders to reach those in danger, and for construction crews to access and repair damaged infrastructure elsewhere. Roadway functional classification, existence and length of available detours, average daily traffic, businesses and homes serviced, and proximity to emergency facilities and anchor businesses may be used to determine a structure's relative importance. The following recommendations are offered for bridges.

North Montgomery Hollow Road:

- This bridge was found to be undersized, acting as a moderate hydraulic constriction during the 10-year flood event and greater. The left side of the bridge embankment is flanked during the 100-year flood event and greater, potentially flooding the adjacent roadway.
- For the next regularly scheduled replacement of the bridge, a detailed hydrologic and hydraulic assessment for the replacement structure is recommended.

NYS Route 30 Bridge over EBDR:

- The bridge was found to be undersized and acting as a hydraulic constriction during the 25-year flood event and greater. The bridge may flood roadway to north during the 100- and 500-year storm events. The area upstream of the bridge consists primarily of grasslands and farm fields.
- Town pump station is located on the right overbank immediately upstream of the bridge. However, it was noted that this location has not experienced flooding in the past.
- When the bridge is scheduled for replacement, it is recommended that a full hydraulic assessment be conducted to ensure that the new bridge meets NYSDOT design criteria.

Roxbury Central School Bridge:

- The bridge is only capable of conveying the 10-year flood event, flanking during the 25-year storm and greater. The area upstream of the bridge consists primarily of forested floodplain.
- Closure of the bridge is recommended when major floods are forecast.
- The structure poses no imminent threat. No further recommendations are made for this bridge besides regularly programmed inspection for structural soundness.

County Route 41 (Bridge Street Bridge):

- It is recommended that the village work with Delaware County to prioritize design and replacement of the bridge and secure funds.
- It is recommended that a full hydraulic assessment be conducted to ensure that the replacement bridge meets NYSDOT design criteria.

6.1.3 Kirkside Park

Kirkside Park is a historic site that serves the community as a common location for recreational activities and a venue for local town events. A recommendation has been made for the upkeep of Pleasant Valley Brook at the confluence with the EBDR in order to reduce prevalent flooding of the nearby fields. Furthermore, it is recommended that the town continue working closely with DCSWCD to develop a proper solution that will not impair the current ecological state of the existing stretch of stream.

6.2 Hamlet of Grand Gorge

6.2.1 Bridges

NYS Route 30 Bridge over Bear Kill:

- No reports of flooding or overtopping have been received from the public.
- Hydraulic assessment indicates that the bridge can pass the 10-year storm event but is overtopped during the 25-year flood and greater although it does not flood buildings upstream.
- It is recommended that a full hydraulic assessment be conducted to ensure that the replacement bridge meets NYSDOT design criteria.

6.2.2 Floodplain Bench Enhancement Scenarios

The proposed floodplain bench scenarios explored in this report are being recommended to the town as future flood mitigation alternatives along the Bear Kill. All the assessed scenarios resulted in significant inundation extent reductions and therefore would be beneficial for the residents of Grand Gorge. Moreover, if the town decides to implement any of the suggested mitigation alternatives, it might be in the town's best interest to once again pursue the remapping of the FEMA flood zone for the Bear Kill. A rigorous hydrologic and hydraulic assessment should be performed for the design of each floodplain bench enhancement scenario.

6.3 Flood-Prone Homes and Buildings

During the course of gathering information from Roxbury and Grand Gorge residents, MMI was informed that several properties in town suffered considerable damages during Tropical Storm Irene. Within the hamlet of Roxbury, several homes are mapped bordering the SFHA. Other properties may not be included in these delineated floodplains but incurred substantial flood damages from tributaries. In Grand Gorge, no flooding from the Bear Kill was reported by the public. It is recommended that property owners who have experienced flooding damage in the

past seek appropriate flood mitigation strategies whether through buyouts, relocation, or building elevation. A fairly comprehensive description of potential sources of funding for flood mitigation and damage reduction projects is included in Section 7.0 of this report. Residents may consult the current effective FEMA FIRM to determine the location of their home relative to the SFHA, which is the area inundated by flooding during the 100-year flood event.

The effective FIRM products for the Town of Roxbury at the time of this report are available here: https://msc.fema.gov/portal/availabilitySearch?addcommunity=361036&communityName=ROXBURY,%20TOWN%20OF#searchresultsanchor

Residents may also search for their home address directly by visiting: https://msc.fema.gov/portal/home

- It is recommended that the town and village work to floodproof or relocate the most flood-vulnerable properties where there is owner interest and programmatic funding available through flood buyout and relocation programs. The two flow charts below provide decision-making guidance for nonresidential (Figure 6-1) and residential (Figure 6-2) properties.

- It is recommended that the town identify priority areas and structures that are prone to most frequent and deepest flooding. These areas should be considered the highest priority for individual flood protection measures.

Some of the homes in the SFHA are rarely flooded. Residents and businesses may benefit from minor individual property improvements. Providing landowners with information regarding individual property protection is recommended.

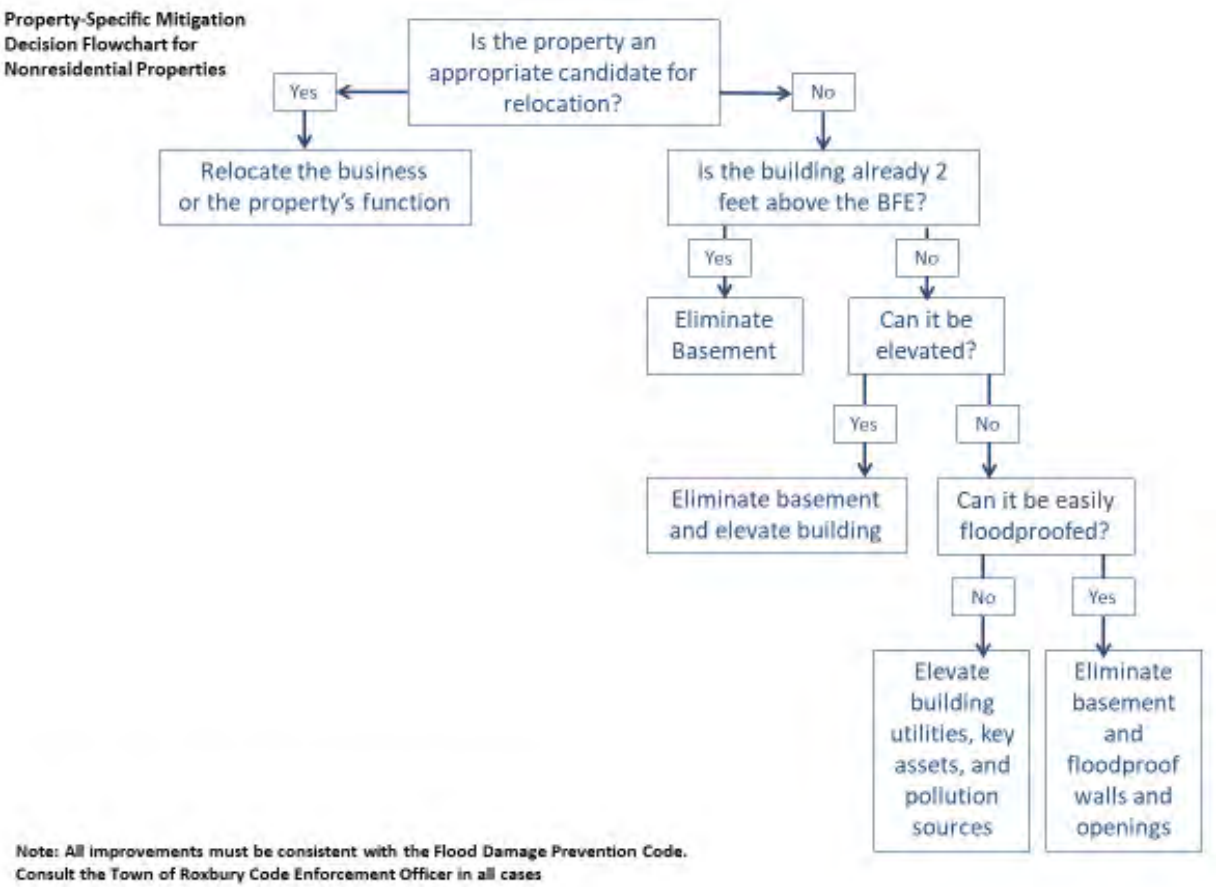


Figure 6-1
Property-Specific Mitigation for Nonresidential Properties

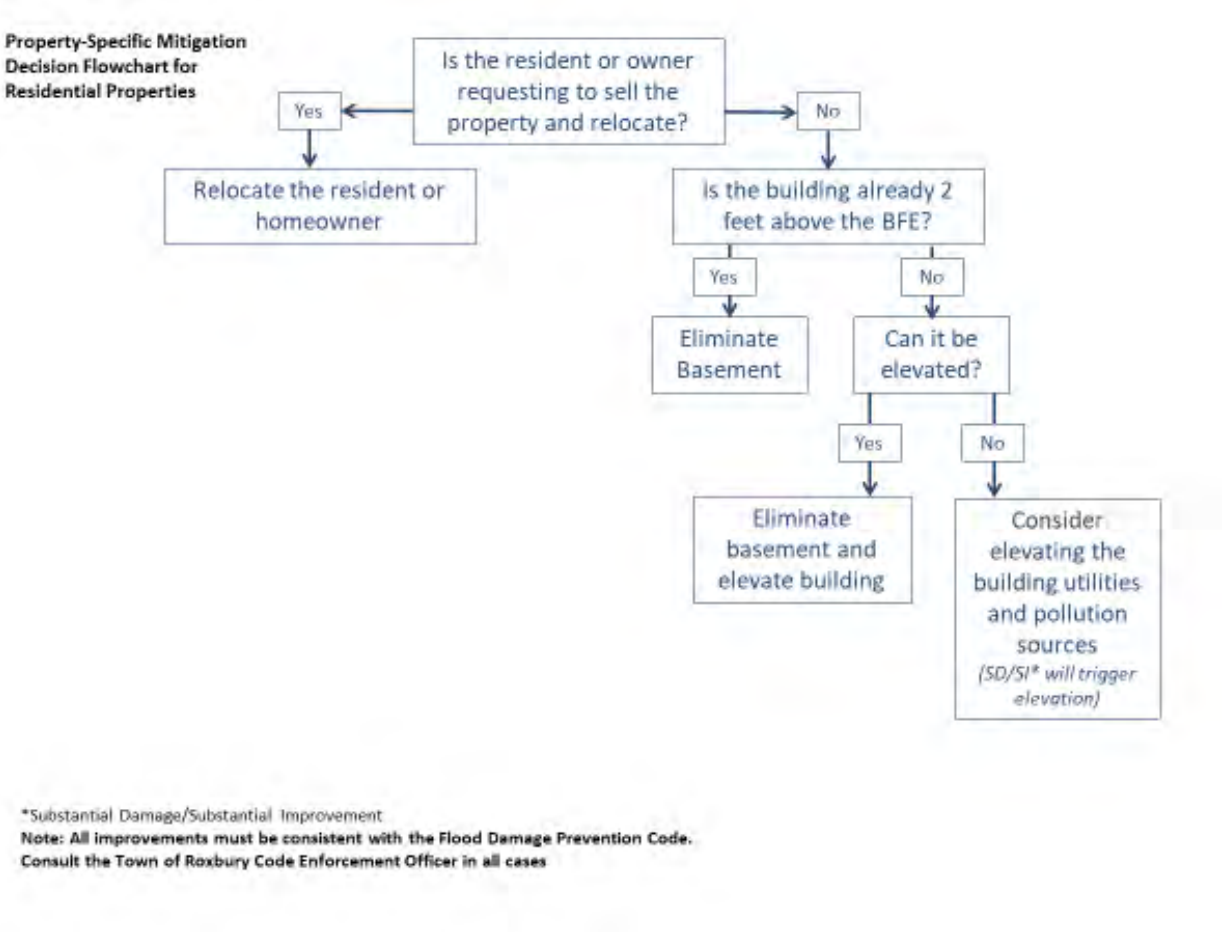


Figure 6-2
Property-Specific Mitigation for Residential Properties

In areas that are vulnerable to flooding, improvements of individual properties and structures may be appropriate. All practices to protect property within a floodplain must comply with local flood law and obtain the approval of the town floodplain administrator or code enforcement officer. Potential measures for property protection include the following:

Elevation of the structure – Home elevation entails the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located 2 feet or more 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 first-floor level or installed from basement joists or similar mechanism at an elevation no less than 2 feet above the BFE.

Dry floodproofing of the structure to keep floodwaters from entering – 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.

Wet floodproofing of the structure to allow floodwaters to pass through the lower area of the structure unimpeded – Wet floodproofing refers to intentionally letting floodwater into a building to equalize interior and exterior water pressures. Furniture and electrical appliances should be moved away or elevated above the 100-year flood elevation. Wet floodproofing should only be considered as a last resort.

Performing other home improvements to mitigate damage from flooding – 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.
- Relocate or elevate water heaters, heating systems, washers, and dryers to a higher floor or to at least 12 inches above the BFE.
- Anchor fuel tanks to the wall or floor with noncorrosive metal strapping and lag bolts.
- Install a backflow valve to prevent sewer or septic backup into the home.
- Install a floating floor drain plug at the lowest point of the lowest finished floor.
- 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.

Encouraging property owners to purchase flood insurance under the 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, which will increase the eligibility of the property for projects under the various mitigation grant programs.

Construction of property improvements such as barriers, floodwalls, and earthen berms – Such structural projects can be used to prevent shallow flooding. There may be properties within the town where implementation of such measures will serve to protect structures. Such barriers must not be permitted unless designed by a qualified engineer and shown to comply with NFIP and local floodplain laws. These improvements are not eligible for funding under CWC or Stream Management Plan – Flood Hazard Mitigation (SMP-FHM) grant programs.

A report was received from a property owner along the EBDR just upstream of Bridge Street, who reported that flooding of outbuildings had worsened on their property following the installation of a sewer system that entailed excavation, grading, and installation of a manhole and resulted in the creation of a hillock on the property. It is recommended that the town investigate and determine whether regrading could be undertaken to correct this issue.

6.4 General Recommendations

Flooding of, and damage to, bridges, culverts, and roadways during flood events have been reported at numerous locations in the hamlets of Roxbury and Grand Gorge. It is recommended that risks associated with the flooding of bridges and roadways be reduced by temporarily closing flood-prone roads during high-flow events. This requires effective signage, road closure barriers, and consideration of alternative routes. Because it is impossible to prepare for every contingency and closing roads and establishing detours in a flash flood event is not always possible, it is

critical that residents be advised of the extreme dangers of attempting to cross flooded roadways and reminded not to do so when flooding occurs or is forecasted. Informed and prepared residents are the foundation of life safety preservation in floods.

In the event of future flooding, it is highly recommended that the Town of Roxbury collect and maintain clear, detailed records of all damages and associated repair costs, including materials and labor. These should be distinguished by site so that problem areas can be identified and addressed and not lost amongst the overall total. Where possible, once waters recede and it is safe to do so, high water marks and other evidence of flooding extents should be photographed and carefully documented and their elevations measured from a permanent reference. These data may be extremely valuable when seeking funding for flood mitigation assistance.

During the LFA process, MMI received a hard copy of the stormwater assessment report that was conducted for the Hamlet of Roxbury. The report entailed a thorough evaluation of the various stormwater drainage systems within the hamlet and provided the town with viable long-term and short-term solutions for flood reductions and water quality improvements. It is recommended that a drainage study also be conducted for the Hamlet of Grand Gorge seeing that many of the problems voiced during public meetings related to stormwater runoff and the receiving drainage systems.

Public welfare depends on awareness and proper enforcement of the town's local Flood Prevention Law. It is recommended that town government staff seek training regarding the content and implementation of this law, especially the Town Code Enforcement Officer. As the Local Administrator, this individual is responsible for administering, implementing, and enforcing the local Flood Damage Prevention Code. This will allow town officials to successfully disseminate important information regarding the law to the public and to implement the law accurately to meet its stated purposes (Section 2.1).

It is recommended that the Town of Roxbury maintain its status in the NFIP and regularly participate in a Community Assistance Visit (CAV). The CAV is a major component of the NFIP's Community Assistance Program (CAP). The CAV is a visit to a community by a FEMA staff member or staff of NYSDEC on behalf of FEMA that serves the dual purpose of providing technical assistance to the community and assuring that the community is adequately enforcing its floodplain management regulations. Generally, a CAV consists of a tour of the floodplain, an inspection of community permit files, and meetings with elected officials. If any administrative problems or potential violations are identified during a CAV, the community will be notified and given the opportunity to correct those administrative procedures and remedy the violations to the maximum extent possible within established deadlines. FEMA or NYSDEC will work with the community to help it bring its program into compliance with NFIP requirements. In extreme cases where the community does not take action to bring itself into compliance, FEMA may initiate an enforcement action against the community. For Roxbury to be eligible for funding under the CWC FHMIP or the Stream Management Program LFA, the town needs to participate in a CAV. According to NYSDEC, as of January 20, 2020, Roxbury has never completed a CAV.

During public meetings, there was discussion surrounding beaver dams along the Bear Kill and EBDR. Residents expressed concern about collapsing beaver dams at the headwaters causing a large surcharge of water to travel downstream in a very destructive manner, hence threatening

public safety and properties. Although a very legitimate concern, beavers and beaver dams also serve an important role in maintaining a healthy and balanced ecosystem. Water impounded by beaver dams can provide habitat for wildlife and can also help with preserving wetlands. Hence, it is recommended that the Town of Roxbury follow the necessary permitting procedures set by NYSDEC for the control of beaver and beaver dams. Additional information regarding beaver dam best management practices is available at: https://www.dec.ny.gov/animals/6992.html.

7.0 FUNDING SOURCES

Funding for culvert replacements and other infrastructure upgrades is often scarce in a small community. In a 2017 survey of county, city, town, and village officials in NYS conducted by Aldag et al. of Cornell University, 80 percent of responders reported that infrastructure needs contribute to local fiscal stress, and 86 percent said that fiscal stress affects local infrastructure budgeting. The consequence is that local governments that are fiscally stressed are likely to have substantial needs for infrastructure investment but must defer addressing them (NYS Comptroller, 2017). Because of this, external funding is often necessary, and a concerted effort is required to secure these grants although small local governments may not have staff available to dedicate to these endeavors.

Several funding sources may be available for the implementation of recommendations made in this report, listed in Table 7-1. These and other potential funding sources are discussed in further detail below. Note that these may evolve over time as grants expire or are introduced.

TABLE 7-1
Potential Funding Sources for Flood Mitigation Alternatives

Recommendation	Potential Eligibility		
	Federal	State	Other
Replacement of assessed bridges with an appropriately sized structure		Bridge NY, NYSDOT	Delaware County, CWC, SMIP-FHM
Replacement and daylight of culverts carrying Vega Mountain Stream	FEMA	Bridge NY, NYSDOT	Delaware County, CWC, SMIP-FHM
Replacement of undersized culverts	FEMA	Bridge NY, NYSDOT	Delaware County, CWC, SMIP-FHM
Debris removal following floods	USACE, EWP		CWC
Floodplain enhancements	FEMA		SMIP-FHM
Install floodproofing at critical facilities and anchor businesses	FEMA		CWC
Floodproof or relocate the most flood-vulnerable properties where there is owner interest	FEMA		CWC; NYCFFBO
Anchor fuel tanks			CWC
Feasibility study to assess individual flood mitigation alternatives for properties			CWC

USACE = United States Army Corps of Engineers
FHM = Flood Hazard Mitigation
EWP = Emergency Watershed Protection Program
SMIP = Stream Management Implementation Program
NYCFFBO = New York City Funded Flood Buyout Program

Stream Management Implementation Program Flood Hazard Mitigation Grants (SMIP-FHM)
FHM is a funding category in the SMIP for LFA communities and those participating in the NY Community Reconstruction Program. Municipalities may apply to implement one or more recommendations contained in their LFA and approved by the municipal board. All projects must have modeled off-site flood reduction benefits. Eligible projects include the following:

- Design/construction of floodplain restoration and reconnection
- Design/construction of naturally stable stream channel dimensions and sediment transport processes
- Design/construction of public infrastructure to reduce water velocity, flow path, and/or elevation
- Correction of hydraulic constrictions

Ineligible projects include construction of floodwalls, berms, or levees; stream dredging; routine annual maintenance; or replacement of privately owned bridges, culverts, or roads. Municipalities must apply to the SMP in their respective counties. Contact information for Delaware County, New York, is as follows:

Delaware County Soil and Water Conservation District
44 West Street, Suite 1
Walton, NY 13856
Phone: (607) 865-7161

New York City Funded Flood Buyout Program
The New York City Funded Flood Buyout Program (NYCFFBO) is a voluntary program intended to assist property owners who were not eligible for, or chose not to participate in, the FEMA flood buyout program. It is intended to operate between flood events, not as an immediate response to one. Categories of eligible properties include the following:

1. Properties identified in community LFAs
2. Anchor businesses, critical community facilities, and LFA-identified properties applying to the CWC for relocation assistance
3. Properties needed for a stream project
4. Erosion hazard properties
5. Inundation properties

Risk assessments and BCA are required for these purchases. Municipalities may choose to own and manage the properties after they are purchased and cleared of structures. Conservation easements must be given to NYSDEC, and there are limits to what may be placed on these parcels. Allowed structures are public restrooms served by public sewers or by septic systems whose leach field is located outside the 100-year floodplain, or open-sided structures such as gazebos and pavilions.

The NYCFFBO is governed by the Water Supply Permit and the Property Evaluation and Selection Process document (Process document). Communities work through outreach and assessment leads appointed by the municipality to inform potential applicants about the program and

evaluate the eligibility of properties based on the program criteria established in the Process document.

Local Flood Hazard Mitigation Implementation Program

The CWC funds LFA-recommended projects to prevent and mitigate flood damage in the West of Hudson watershed, specifically to remedy situations where an imminent and substantial danger to persons or properties exists or to improve community-scale flood resilience while providing a water quality benefit.

Municipalities and individual property owners may apply directly to the CWC. Municipalities may apply for grants for projects identified in an LFA or New York Rising planning process.

Eligible LFA-derived projects could include the following:

- Alterations of public infrastructure that are expected to reduce/minimize flood damage
- Private property protection measures such as elevation or floodproofing of a structure
- Elimination of sources of man-made pollution such as the relocation or securing of fuel oil/propane tanks
- Stream-related construction (Ineligible projects include construction of floodwalls, berms, or levees; stream dredging; or annual maintenance.)
- Relocation assistance for a residence or business recommended by an LFA to a location within the same town or village

Property owners may apply for the following assistance:

- Funds for relocation assistance of an anchor business. Anchor businesses must be located in a floodplain in a watershed hamlet where an LFA has been conducted though their relocation does NOT have to be recommended in the LFA. These include gas stations, grocery stores, lumber yards and hardware stores, medical offices, or pharmacies, which if damaged or destroyed would immediately impair the health and/or safety of a community.
- Funds for relocation of critical community facilities, such as a firehouse, school, town hall, public drinking water treatment or distribution facility, or wastewater treatment plant or collection system, which if destroyed or damaged would impair the health and/or safety of a community. Facilities must have been substantially damaged by flooding. They do NOT have to be recommended by an LFA but MUST be located in an LFA community.
- Funds for assistance to relocate homes and/or businesses within the same town where the NYCFFBO covers purchase of former property (does NOT have to be in an LFA community)
- Stream debris removal after a serious flood event (does NOT have to be recommended in an LFA)

Sustainable Community Planning Program

This CWC program is for municipalities that have prepared LFAs. It is intended to fund revisions of local zoning codes or zoning maps or to upgrade comprehensive plans in order to identify areas within those municipalities that can serve as new locations for residences and/or businesses to be moved after purchase under the voluntary NYCFFBO. Grants of up to $20,000 are available through this program, part of the CWC's Local Technical Assistance Program. The CWC program

rules can be accessed by clicking the 'Flood Hazard Mitigation Program Rules' link found here: http://cwconline.org/fhmi-program-overview

Emergency Watershed Protection Program (EWP)

Through the EWP program, the U.S. Department of Agriculture's Natural Resources Conservation Service (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.

FEMA Pre-Disaster Mitigation (PDM) Program

The PDM 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 PDM 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.
https://www.fema.gov/pre-disaster-mitigation-grant-program

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.
https://www.fema.gov/hazard-mitigation-grant-program

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 RFC 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.
http://www.fema.gov/flood-mitigation-assistance-grant-program

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.

NYS Department of Environmental Conservation – Municipal Waste Reduction and Recycling (MWRR) Program

The NYS Department of Environmental Conservation (DEC) administers MWRR funding to local government entities for waste reduction and recycling projects. The overall goal of this funding program is to assist municipalities in expanding or improving local waste reduction and recycling programs and to increase participation in those programs.

The MWRR state assistance program can help fund the costs of the following:

- Capital Investment in Facilities and Equipment

Eligible projects are expected to enhance municipal capacity to collect, aggregate, sort, and process recyclable materials. Recycling equipment includes structures, machinery, or devices providing for the environmentally sound recovery of recyclables including source separation equipment and recyclables recovery equipment.

U.S. Army Corps of Engineers (USACE)

The USACE provides 100 percent funding for floodplain management planning and technical assistance to states and local governments under several flood control acts and the Floodplain Management Services Program (FPMS). Specific programs used by the USACE for mitigation are listed below.

- Section 205 – Small Flood Damage Reduction Projects: This section of the 1948 Flood Control Act authorizes the USACE to study, design, and construct small flood control projects in partnership with nonfederal government agencies. Feasibility studies are 100 percent federally funded up to $100,000, with additional costs shared equally. Costs for preparation of plans and construction are funded 65 percent with a 35 percent nonfederal match. In certain cases, the nonfederal share for construction could be as high as 50 percent. The maximum federal expenditure for any project is $7 million.

- Section 14 – Emergency Stream Bank and Shoreline Protection: This section of the 1946 Flood Control Act authorizes the USACE to construct emergency shoreline and stream bank protection works to protect public facilities such as bridges, roads, public buildings, sewage treatment plants, water wells, and nonprofit public facilities such as churches, hospitals, and schools. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $1.5 million.

- Section 208 – Clearing and Snagging Projects: This section of the 1954 Flood Control Act authorizes the USACE to perform channel clearing and excavation with limited embankment construction to reduce nuisance flood damages caused by debris and minor shoaling of rivers. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $500,000.

- Section 206 – Floodplain Management Services: This section of the 1960 Flood Control Act, as amended, authorizes the USACE to provide a full range of technical services and planning guidance necessary to support effective floodplain management. General technical assistance efforts include determining the following: site-specific data on obstructions to flood flows, flood formation, and timing; flood depths, stages, or floodwater velocities; the extent, duration, and frequency of flooding; information on natural and cultural floodplain resources; and flood loss potentials before and after the use of floodplain management measures. Types of studies conducted under FPMS include floodplain delineation, dam failure, hurricane evacuation, flood warning, floodway, flood damage reduction, stormwater management, floodproofing, and inventories of flood-prone structures. When funding is available, this work is 100 percent federally funded.

In addition, the USACE provides emergency flood assistance (under Public Law 84-99) after local and state funding has been used. This assistance can be used for both flood response and postflood response. USACE assistance is limited to the preservation of life and improved property; direct assistance to individual homeowners or businesses is not permitted. In addition, the USACE can loan or issue supplies and equipment once local sources are exhausted during emergencies.

Other Potential Sources of Funding

New York State Grants

All New York State grants are now announced on the NYS Grants Gateway. The Grants Gateway is designed to allow grant applicants to browse all NYS agency anticipated and available grant opportunities, providing a one-stop location that streamlines the way grants are administered by the State of New York.
https://grantsmanagement.ny.gov/

Bridge NY Program

The Bridge NY program, administered by NYSDOT, is open to all municipal owners of bridges and culverts. Projects are awarded through a competitive process and support all phases of project development. Projects selected for funding are evaluated based on the resiliency of the structure, including such factors as hydraulic vulnerability and structural resiliency; the significance and importance of the bridge including traffic volumes, detour considerations, number and types of businesses served and impacts on commerce; and the current bridge and culvert structural conditions.
https://www.dot.ny.gov/BRIDGENY.

Private Foundations

Private entities such as foundations are potential funding sources in many communities. The Town of Roxbury and FAC members will need to identify the foundations that are potentially appropriate for some of the actions proposed in this report.

In addition to the funding sources listed above, other resources are available for technical assistance, planning, and information. While the following sources do not provide direct funding, they offer other services that may be useful for proposed flood mitigation projects.

Land Trust and Conservation Groups

These groups play an important role in the protection of watersheds, including forests, open space, aquatic ecosystems, and water resources.

As the recommendations of this LFA are implemented, the Town of Roxbury will need to work closely with potential funders to ensure that the best combinations of funds are secured for the proposed alternatives and for the property-specific mitigation such as floodproofing, elevations, and relocations. It will be advantageous for the town to identify combinations of funding sources in order to reduce its own requirement to provide matching funds.

REFERENCES

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

Chemung County Soil & Water Conservation District, 2006. Stream Processes. A Guide to Living in Harmony with Streams

Connecticut Department of Transportation, 2000. Drainage Manual, sec. 6.12.3.

Delaware County NY Genealogy and Historic Site. Villages, Hamlets, and Settlers in the town of Roxbury. https://www.dcnyhistory.org/roxburyindex.html

Delaware County Soil and Water Conservation District, 2007. East Branch Delaware River Stream Corridor Management Plan

FEMA, Flood Insurance Study, Delaware County, New York (All Jurisdictions). Federal Emergency Management Agency Flood Insurance Study Number 36025CV001B through 36025CV005B. Revised: June 16, 2016

FEMA, 2013. Memorandum: HMA Cost Effectiveness Determinations for Acquisitions and Elevations in Special Flood Hazard Areas Using Precalculated Benefits

Lumia, Richard, 1991. U.S. Geological Survey, Regionalization of Flood Discharges for Rural, Unregulated Streams in New York, Excluding Long Island. Water-Resources Investigations Report 90-4197. Albany, NY

Lumia, Richard, Freehafer, D.A., and Smith, M.J., 2006. Magnitude and frequency of floods in New York: U.S. Geological Survey Scientific Investigations Report 2006–5112, 152 p.

Mulvihill, C., Baldigo, B., Miller, S., and DeKoskie, D., 2009. Bankfull Discharge and Channel Characteristics of Streams in New York State, U.S. Geological Survey, Reston, VA

NYCDEP, 2014. NYC Watershed Stream Management Program Local Flood Analysis (LFA) Program Rules, Final Version

Tetra Tech, 2013. Delaware County Multi-Jurisdictional Hazard Mitigation Plan Update, Volume 1

5197-15-06-j3120-rpt.docx

APPENDIX A

FAC Meeting Minutes

MILONE & MACBROOM

MEMORANDUM

TO:	Roxbury Flood Advisory Committee
FROM:	Milone & MacBroom, Inc.
RE:	Roxbury and Grand Gorge LFA FAC Kick-Off Meeting
DATE:	April 3, 2019
MMI #:	5197-15

A kick-off meeting for the Roxbury and Grand Gorge Local Flood Analysis (LFA) was held on the evening of April 2, 2019 at the Roxbury Town Hall. In attendance were Mark Carabetta, Miguel Castellanos and Ethan Ely from Milone and MacBroom (MMI), as well as members of the Roxbury Flood Advisory Committee (FAC). FAC members included representatives from the hamlets of Roxbury and Grand Gorge, the New York City Department of Environmental Protection (NYCDEP), the Delaware County Soil and Water Conservation District (DCSWCD), and local business owners and residents. A sign-in sheet and the presentation slides are appended.

The purpose of the meeting was to:

- Review the study areas
- Recap the LFA process and intended outcomes
- Collect information about flooding, flood damage and future town improvements
- Discuss next steps in the LFA process and set a date for the first public meeting

The meeting began with introductions and a short presentation of the LFA process and intended outcomes. During the presentation, MMI discussed what is known about the flood history in Roxbury and Grand Gorge, steps involved in an LFA, and potential flood mitigation strategies. Flood mitigation strategies from other LFA studies in the Catskills were presented to provide examples of options that may be recommended in the Hamlets of Roxbury and Grand Gorge.

Following the presentation, members of the committee discussed their experiences with flooding. MMI provided large scale maps so that flood advisory members could identify areas where flood damage occurred. MMI staff collected information and took detailed notes.

The meeting included a discussion of next steps and setting a date for the first public meeting, where more information on flooding will be gathered. The meeting will take place Tuesday, May 7 at 7PM at the Roxbury Town Hall.

Following is a summary of notes collected at the meeting:

Grand Gorge

- Flood of record took place in 1996, no other major flooding to report otherwise.
- Woidt Engineering was retained to map the FEMA floodplain, which previously had been completed using approximate methods. Products of this work included a hydraulic model of the Bear Kill. Results of the mapping were disputed and ultimately the revised maps were not adopted.
- Beaver dams at the headwaters of the Bear Kill haven't been a major issue in the past.

Roxbury

- Flood of 1996 was more devastating than tropical storm Irene in 2011.
- Vega Mountain Rd bridge becomes plugged with debris during storms; water spills down Main Street and Bridge Street. Low spot on Route 30, north of Main Street-Bridge Street intersection, flooded with 2-3 feet of water during Irene. This occurred in 1996, 2011, and during other floods.
- US Army Corp of Engineers reportedly built Vega Mountain stream culvert that runs under Route 30 in the 1980's.
- After Irene, Vega Mountain stream channel was widened and banks laid back and armored with stone slabs.
- Vega Mountain stream alignment reportedly may have been altered sometime in the 1800th century.
- Culvert at Johnson Road and Vega Mountain Road intersection is frequently washed out and replaced.
- A drainage project on Lake Street, approximately 10 years ago, solved flooding problems for homes along Lake Street.
- Athletic fields behind school flood.
- Pleasant Valley Brook delivers sediment to confluence with East Branch Delaware River. Tetra Tech is currently working on the design to repair bank failure up Pleasant Valley Brook.
- No flooding known to occur to properties immediately upstream of the Montgomery Hollow Road bridge.
- Noted critical facilities: Firehouse, Roxbury School, Roxbury Town Hall, water supply wells (upstream of Route 30 bridge), wastewater pump stations to Grand Gorge (downstream Bridge Street).
- Noted anchor businesses: Radio station, hotel.

Comments Tied to Maps:

1. Approximate location of bank failure on Pleasant Valley Brook.
2. Location of elevated home that was funded through New York Rising. Other homes in the immediate vicinity are still flooded.
3. Vega Mountain Road/Johnson Road culvert that was replaced after a 2018 storm event.
4. Roxbury Fire Department, past floodwaters haven't reached farther than the back of the building.
5. Pump system that goes to Grand Gorge.

Schedule and Plan for Public Meeting

A public meeting will be convened for the purpose of gathering information on flooding in the study areas. The meeting will be held at the Roxbury Town Hall at 7pm on Tuesday, May 7. MMI will provide the FAC with a list of addresses located within the FEMA floodplain of the East Branch Delaware River and Bear Kill, and those in close proximity to Vega Mountain and Pleasant Valley tributaries. MMI will also provide an example of a postcard invitation to the public meeting.

MEETING SIGN-IN SHEET

MILONE & MACBROOM	Meeting Date: 7:00PM
Project: Roxbury & Grand Gorge LFA	Place/Room: Roxbury Town Hall

Name	Company	Phone	E-Mail
Mark Carabetta	Milone & MacBroom, Inc	(845) 633-8153	mcarabetta@mminc.com
Ethan Ely	Milone & MacBroom, Inc	(845) 633-8153	eely@mminc.com
Miguel Castellanos	Milone & MacBroom, Inc	(845) 633-8153	mcastellanos@mminc.com
Tom Hynes	Town of Roxbury Supervisor	(607) 326-7641	townsupervisor@roxburyny.com
Allen Hinkley	Town Council	(607) 326-4293	ahinkley@catskill.net
Carol Murray	Town Council	(607) 588-6128	Redsauto25@gmail.com
Ed Raeder	Town Council	(607) 588-6023	edsue@catskill.net
Diane Pickett	Town Clerk	(607) 326-7641	townclerk@roxburyny.com
Ben Dates	DCSWCD	(607) 865-5223	ben-dates@dcswcd.org
Phil Eskeli	NYCDEP	(845) 340-7853	peskeli@dep.nyc.gov
Mary Hynes	Roxbury Resident		

MILONE & MACBROOM

MEMORANDUM

TO:	Roxbury Flood Advisory Committee
FROM:	Milone & MacBroom, Inc.
RE:	Roxbury and Grand Gorge LFA Public Meeting #1
DATE:	May 7, 2019
MMI #:	5197-15

The first public meeting for the Roxbury and Grand Gorge Local Flood Analysis (LFA) was held on the evening of May 7, 2019 at the Roxbury Town Hall. Invitations to attend the meeting had been mailed out to landowners with property located within the FEMA 100-year flood zone along the East Branch of the Delaware River and the Bear Kill, and along the Vega Mountain and Pleasant Valley Brook tributaries. In attendance were Mark Carabetta, Ethan Ely and Miguel Castellanos from Milone and MacBroom (MMI), as well as members of the Roxbury Flood Advisory Committee (FAC). FAC members included representatives from the hamlets of Roxbury and Grand Gorge, the New York City Department of Environmental Protection (NYCDEP), the Catskill Watershed Corporation (CWC), the Delaware County Soil and Water Conservation District (DCSWCD). Several members of the public who reside in the hamlets of Roxbury and Grand Gorge were in attendance and provided valuable input.

The purpose of the meeting was to:

- Review the study areas
- Recap the LFA process and intended outcomes
- Collect information from the public about flooding and flood damages

The meeting began with introductions and a presentation of the LFA process and intended outcomes. During the presentation, MMI discussed what is known about the flood history in Roxbury and Grand Gorge, steps involved in an LFA and potential flood mitigation strategies. Following the presentation, members of the committee and the public discussed their experiences with flooding. MMI provided large scale maps so that individuals could identify areas where flood damage occurred. MMI staff collected information and took detailed notes.

Written responses from property owners that were unable to attend the meeting were provided to the town board, and were shared with MMI. Two attendees brought portable drives to the meeting containing photos taken during previous flood events, which MMI copied for their records.

MMI will now begin its flood analysis, and will present the initial findings at the next FAC meeting, which will be scheduled for June (date to be determined).

A sign-in sheet and presentation slides from the meeting are appended.

PUBLIC INFORMATION MEETING — T/Roxbury
Local Flood Analysis (LFA)
May 7, 2019 @ 7:00 pm Town Hall

	Name	Street Address	Telephone #
1	Thomas S. Hynes	Town Supr	607-326-7921
2	Diane Pickett	37399 St. Hwy 23	607-326-7641 Town Clerk
3	Miguel Castellanos	Milone & MacBroom 231 main st, suite 2, New Paltz	(845)633-8153
4	Ethan Ely	MMI	"
5	John Mathiesen	CWC-Margaretville	845 586-1400
6	Mark Carabetta	MMI	845-633-8153
7	JOHN GANGLOFF	1 STRATTON FALLS RD	607-326-4936
8	Nancy Haney	60899 SH 30 GG, NY 12434	607-588-6127
9	ARMANDO LOPEZ	140 Shepard Land	607 326 6041
10	GALE A. NEALE	44 West St. Walton NY	607 437-9863
11	Richard DyKstra	54063 ST Hwy 30 Roxbury	607 326-6116
12	Jeannette Thompson	80 Spruce St Roxbury	607 326-7980
13	Joseph R. Reschke	37077 St. Hwy 23 Grand Gorge	607-588-6804
14	JOHN I. SPARIOSU	8838 CR 41	607-326-2990
15	Jim Brownell	Rt 23 36453 Grand Gorge	607-588-7828
16	Yang Conliffe	36473 Rt. 23	
17	Joann Barrata	37004 Rt. 23	email rec'd
18	Patrick Russell	2343 Cty Hwy 41	email rec'd
19	Arthur Pitteti	205 Hubbell Corn. Rd.	
20	Phil Eskeli	NYCDEP	845-340-7853
21			
22			
23			
24			
25			

MILONE & MACBROOM

MEMORANDUM

TO:	Roxbury Flood Advisory Committee
FROM:	Milone & MacBroom, Inc.
RE:	Roxbury and Grand Gorge LFA FAC Meeting #2
DATE:	June 18, 2019
MMI #:	5197-15

A meeting for the Roxbury and Grand Gorge Local Flood Analysis (LFA) was held on the evening of June 18, 2019 at 7pm at the Roxbury Town Hall. In attendance were Mark Carabetta, Miguel Castellanos and Ethan Ely from Milone and MacBroom (MMI), as well as members of the Roxbury Flood Advisory Committee (FAC). A sign-in sheet and the presentation slides are appended.

The purpose of this meeting was to:

- Review and discuss preliminary modeling results
- Decide on next steps
- Set date for FAC Meeting #3

The following areas were discussed:

1. Vega Mountain Tributary

The Vega Mountain tributary passes through three culverts, all consisting of 4-foot diameter pipes. The area along the tributary floods severely and frequently, primarily due to water spilling out at the culvert under Vega Mountain Road. When it floods, water flows down Vega Mountain Road and on to Main Street, damaging multiple properties. A resident who lives near the Creek identified approximately 16 buildings which were damaged by the flooding during Tropical Storm Irene. The contributing watershed is only 1.1 square miles, but is very steep. Peak discharges were determined for various rainfall events with recurrence intervals ranging from 1-year to 100-years. Hydraulic analysis indicates that all three culverts pass the 1-year peak flood flow but do not pass the 5-year flow. The culvert under Vega Mountain Road is sensitive to clogging with sediment and debris, and when approximately 30% clogged fails to pass the 1-year flood.

One potential solution was presented by MMI for consideration and discussion by the group. This scenario would need to be constructed progressing from downstream to upstream, and would entail acquisition, demolition and removal of the structures on one property along Main Street and conversion to a town park. The underground sections of the channel that do not pass under a roadway would be opened up (daylighted). Each of the three culverts would be replaced with larger structures. The culvert under Main Street would be replaced with a 20 foot x 5 foot concrete box culvert; the culvert under Vega Mountain Road would be replaced with an 18 foot x 4 foot concrete box culvert; the culvert near Johnson Road would be replaced with a 12 foot x 5 foot concrete box culvert.

It was suggested that a solution could be designed that would entail allowing water to overflow at the Vega Mountain Road culvert and flow down Vega Mountain Road and across Main Street, down Bridge Street to the East Branch of the Delaware River (EBDR). Deployable barriers would be set up at Main Street to direct water. Homes along Vega Mountain Road and Bridge Street would need to be elevated or protected from flooding with deployable barriers.

It was pointed out that the proposed acquisition, demolition and removal of the structures on one property parcel along Main Street may not require that all of the buildings on the property be removed. Several of the buildings are in such poor conditions that they may require demolition anyway. It was suggested that installing grates on top of the daylighted sections of the proposed channel could allow this acquired area to be accessible to the public.

There was also discussion of rerouting the watercourse to avoid having to acquire or demolish structures. One suggestion was to reroute the watercourse through the location of the former Pharmacy.

It was suggested that Delaware County may have records or recommendations relating to Vega Mountain Creek. MMI will inquire with the County.

2. Bridge Street

Hydraulic modeling indicates that this area is flood prone, and that the channel and bridge in this area constrict the channel and contribute to flooding. A scenario was modeled where the current Bridge Street Bridge, with a span of 27 feet, was replaced with a new bridge with a span of 59 feet. Also, a 400-foot long by 40-foot wide by 4-foot deep floodplain bench was modeled alongside the EBDR. This scenario reduced the depth and extent of upstream inundation under a range of flood events, but most of the area subjected to inundation is uninhabited so there is little benefit.

It was noted that Delaware County is the owner of the bridge, and has plans to replace it in the near future. MMI will request design plans from the County. It was also pointed out that there is an additional constriction in the channel further upstream of Bridge Street.

3. Roxbury Central School

The bridge behind the school building was evaluated and found to overtop and flank on both sides during the 10-year flood event. The old bridge at this location was damaged in a flood. It's primary purpose is to provide access to the playing fields for emergency vehicles.

4. NYS Route 30 Bridge

The NYS Route 30 bridge over the EBDR safely passes the 10-year flood. During larger floods, the fields along the right bank (viewed looking downstream) is flooded, but water does not overtop the roadway until close to the 100-year flood event. The town pump station is located in this area but flooding has never been a problem here.

5. Pleasant Valley Confluence

At this location, a delta has formed at the confluence of Pleasant Valley Brook and the EBDR. The channel is higher than the surrounding area and has multiple flow paths, some of which flow directly onto the playing fields. One possible solution would be to redirect the channel and remove some woody debris to reduce (but not eliminate) flooding of fields. This would require regulatory permits. Ben Dates suggested that DCSWCD can provide technical assistance.

Next Steps

For next meeting, MMI will:

- Refine hydraulic analysis and evaluate the considerations and potential solutions suggested by the FAC.
- Assess the Bear Kill in Grand Gorge.
- Begin to develop cost opinions for preferred options.

The next FAC meeting date was set for Tuesday, July 23, 2019, at 7pm at the Roxbury Town Hall

SPECIAL MEETING
June 18, 2019
7:00 PM

1	Thomas Hynes	Supv.		607-326-7641
2	Diane Pickett	T/Clerk		607-326-7641
3	Edward Raeder	Councilman		607-588-6023
4	Mary Hynes	State Hwy 30		607-326-7921
5	Kenneth Savic	Councilman		607-326-4135
6	Carol Murray	Councilwoman		607-588-6128
7	Allen Hinkley	Councilman		607-326-4293
8	BEN DATES, DCSWCD	STREAM PROGRAM ENGR.		607-865-5223
9	PHIL ESKELI	DEP FLOOD HAZ COOR.		845-340-7853
10	Mark Carabetta	Milone & MacBroom		845-633-8153
11	Ethan Eth	MMI		845-633-8153
12	Miguel Castellanos	MMI		845-633-8153
13	Peg Ellsworth	Resident/MARK Proj.		845.586.3500

MILONE & MACBROOM

MEMORANDUM

TO:	Roxbury Flood Advisory Committee
FROM:	Milone & MacBroom, Inc.
RE:	Roxbury and Grand Gorge LFA FAC Meeting #3
DATE:	August 2, 2019
MMI #:	5197-15

A meeting for the Roxbury and Grand Gorge Local Flood Analysis (LFA) was held on the evening of July 23, 2019 at 7pm at the Roxbury Town Hall. In attendance were Mark Carabetta and Miguel Castellanos from Milone and MacBroom (MMI), as well as representatives from the New York City Department of Environmental Protection (NYCDEP), Delaware County Soil and Water Conservation District (DCSWCD), Catskill Watershed Corporation (CWC), and members of the Roxbury Flood Advisory Committee (FAC). During this meeting, the Town Supervisor provided MMI with a copy of a stormwater assessment for Roxbury that was completed by RETTEW Engineering and Surveying, LLC. A sign-in sheet and the presentation slides are appended.

The purpose of this meeting was to:

- Review and discuss refined hydraulic modeling results
- Decide on next steps
- Set date for FAC Meeting #4

The following areas were discussed:

1. Vega Mountain Road Tributary

A refined conceptual approach for flood mitigation along the Vega Mountain Road tributary was presented to the FAC committee. The recommended scenario includes the replacement of the culverts under Vega Mountain Road and State Route 30 with adequately sized structures, as well as increasing the conveyance capacity of the existing channel, and daylighting the sections currently underground. MMI emphasized that this is meant to serve as a long-term solution to the frequent and severe flooding that occurs along the tributary. Until the long-term solution can be implemented, other temporary, short-term solutions, such as deployable flood barriers and floodproofing of homes along Vega Mountain Road, can be recommended in the final report of the study. For the next FAC meeting, MMI will present a comparison between the cost of constructing the new channel and the cost of floodproofing individual buildings that are currently affected by floodwaters.

It was suggested that MMI provide the public with a range of choices, including allowing water to overflow at the Vega Mountain Road culvert and flow down Vega Mountain Road and across Main Street, down Bridge Street to the East Branch of the Delaware River (EBDR). Homes along Vega Mountain Road and Bridge Street would need to be elevated or protected from flooding with deployable barriers.

It was determined by MMI that the alternative of rerouting the watercourse through the location of the former Pharmacy wouldn't be desirable. The tributary that runs along Vega Mountain Road is already considerably steep and rerouting it through this section would decrease its overall length, consequently increasing its slope. This alterative would also require the relocation or demolition of inhabited buildings located on both ends of State Route 30.

It was suggested that DCSWCD may have plans of the culvert under State Route 30, since they previously worked on making an addition to the network of structures. Ben Dates will inquire at DCSWCD.

2. Bridge Street

Prior to the meeting, MMI contacted Delaware County Department of Public Works to obtain an update on the status of the County's plans to replace the Bridge Street bridge. MMI was informed that the project is in its early stages and no design work has been done. Modeling results from last meeting were revisited. It was suggested that having Dan Sanford, Delaware County Department of Public Works Highway Superintendent Engineer, at the next FAC meeting would add tremendous value to the conversation around the replacement of the Bridge Street bridge. MMI will get in contact with Dan and invite him to join the next discussion.

3. Grand Gorge

MMI revised the hydraulic model for the Bear Kill that was provided by DCSWCD. Revisions included a more rigorous analysis of hydrology, and adjustments to the model in the area of the Route 30 bridge. Inundation maps generated by the existing conditions hydraulic model were shown to the FAC members. The mapping of the 100-year flood extent varies considerably when compared to the approximate method delineation of the Special Flood Hazard Area. MMI will continue to validate the model and will also schedule a site visit of the Bear Kill with representatives of the NYCDEP, DCSWCD, and FAC members. Areas of major concern include a section of the stream that is near a trailer park on Park Lane, and various locations where aggradation has been pointed out.

Next Steps

For next meeting, MMI will:

- Evaluate the considerations and potential flood mitigation alternatives suggested for the Bear Kill in Grand Gorge.
- Present cost opinions for preferred options.

A date for the next FAC meeting has been set for Tuesday, September 17, 2019 at 7:00pm at the Roxbury Town Hall. Dan Sanford from Delaware County DPW will be invited to attend.

SPECIAL MTG
July 23, 2019
7:00 PM

1	Thomas Hynes	T/Roxbury	607-326-7641
2	Diane Pickett	" "	" "
3	John Mathiesen	CWC	(845)586-1400
4	Phil Eskeli	DEP	845 340-7853
5	Mary Hynes	Resident	607-326-7921
6	Ken Davie	~~Res~~ T/Roxbury	607 434 5734
7	Edward E Raeder	T/Roxbury	607-588-6023
8	Carol Murray	T/Roxbury	607-588-6128
9	Miguel Castellanos	MMI	845-633-8153
10	Mark Carabetta	MMI	"
11	Ken Dates	DCSWCD	607-865-5225

MILONE & MACBROOM

MEMORANDUM

TO:	Roxbury Flood Advisory Committee
FROM:	Milone & MacBroom, Inc.
RE:	Roxbury and Grand Gorge LFA FAC Meeting #4
DATE:	September 18, 2019
MMI #:	5197-15

A meeting for the Roxbury and Grand Gorge Local Flood Analysis (LFA) was held on the evening of September 17, 2019 at 7pm at the Roxbury Town Hall. In attendance were Mark Carabetta and Miguel Castellanos from Milone and MacBroom (MMI), as well as representatives from the New York City Department of Environmental Protection (NYCDEP), Delaware County Soil and Water Conservation District (DCSWCD), Catskill Watershed Corporation (CWC), Delaware Department of Public Works (DPW), and members of the Roxbury Flood Advisory Committee (FAC). A sign-in sheet and the presentation slides are appended.

The agenda for this FAC meeting was to discuss additional modeling results, provide a summary recap of flood mitigation recommendations, establish a timeline for report review, and set a date for a public meeting to present LFA findings.

Discussion points are summarized below:

1. Grand Gorge

Floodplain Enhancements

MMI, along with members of the NYCDEP, CWC, and FAC performed a site walk of Grand Gorge on August 8, 2019. Two potential sites for flood mitigation solutions were identified in the field and modeling results were presented to the FAC. One alternative considered a proposed floodplain bench enhancement on NYCDEP land located on the opposite bank of the Park Lane mobile home park. This scenario demonstrated significant flood reduction benefits for several homes. It was mentioned during this meeting that NYCDEP would be agreeable to the project being implemented on their land if pushed forward for implementation.

The FAC was presented with a second floodplain enhancement alternative located downstream of NY-30 bridge that runs behind homes and businesses along NY-23. Modeling results also indicated substantial flood reduction benefits in the general vicinity of the floodplain bench.

Approximate cost estimates for each scenario were shared and discussed. It was emphasized that these cost estimates are highly variable on property acquisition and other construction constraints such as utilities. Recommendation for the modeled floodplain bench scenarios, as well as for consideration of other floodplain configurations that appeal to the general public, will be included in the final report.

2. Roxbury

Vega Mountain Rd Tributary

There was mention of frequent ice buildup throughout the section of the tributary that is lined with heavy stone. The long-term solution, discussed in greater detail during past meetings, will be recommended in the final report. It was suggested that the project should be strategically scoped in order to make the

most of available funds. The first step should be to seek funds to have the recommended daylighting and culvert replacements fully designed. This way, the project will be far advanced in engineering design and "shovel ready" for the next round of available funds and construction can begin within a short time.

Pleasant Valley Tributary – Kirk Side Park

DCSWCD has begun working with Roxbury officials to begin permitting the realignment of the highly aggregating reach. It was mentioned that an attempt will be made to plan a site visit sometime in October to collect GPS points at the confluence with the East Branch Delaware River. It was suggested that MMI go forward and still make the recommendations for the Pleasant Valley confluence in the final LFA report.

Individual Structure Measures

It was pointed out that CWC completely funds for the feasibility study for individual homeowners interested in floodproofing measures. CWC's fuel tank anchoring program was emphasized at this meeting, and how many of the properties near East Branch Delaware River, Vega Mountain, and Bear Kill should be taking advantage of this program.

MMI will circulate the first draft of the LFA report to FAC members by early October. FAC deadlines for comments was set for late October. Public meeting to present findings of Roxbury and Grand Gorge LFA was set for **November 19, 2019 at 7:00PM** at the Roxbury Town Hall. MMI will provide the FAC with a list of addresses located within the FEMA floodplain of the East Branch Delaware River and Bear Kill, and those in close proximity to Vega Mountain and Pleasant Valley tributaries. Final draft LFA report will be ready for distribution prior to the public meeting.

LFA Mtg 9/17/19

Tom Hynes	Supv.	607-326-7641
Diane Pickett	T/Clerk	↓
Ed Kaelber	Town Roxbury	
Ken [illegible]	Town RoxBury	
Mary Hynes	Town of Roxbury	
Jim Thomas	Delaware County DPW	607-832-5800
SUE McINTYRE	DelCo DPW	607.832.5800
Bill Sprague	T/Roxbury Deputy Highway Super	
Paul Eskeli	NYC DEP	845 340-7853
Ben Yates	DCSWCD	607-865-5223
Miguel Castellanos	MMI	845-633-8153
Mark Carabetta	MMI	845-633-8153
John Mathiesen	CWC	845 586-1400
Alicia Winkley	T/Roxb.	

MILONE & MACBROOM

MEMORANDUM

TO:	Roxbury Flood Advisory Committee
FROM:	Milone & MacBroom, Inc.
RE:	Roxbury and Grand Gorge LFA Public Meeting #2
DATE:	November 20, 2019
MMI #:	5197-15

A final meeting for the Roxbury and Grand Gorge Local Flood Analysis (LFA) was held on the evening of Tuesday, November 19, 2019 at the Roxbury Town Hall. In attendance were Mark Carabetta and Miguel Castellanos from Milone and MacBroom (MMI), as well as members of the Roxbury Flood Advisory Committee (FAC) and several members of the public. FAC members included officials from the hamlets of Roxbury and Grand Gorge and representatives from the New York City Department of Environmental Protection (NYCDEP), and Delaware County Soil and Water Conservation District (DCSWCD). A sign-in sheet and the presentation slides are appended.

The purpose of the meeting was to:

- Review the LFA process
- Present recommendations for the following topics:
    - Bridges over the East Branch Delaware River in Roxbury and the Bear Kill in Grand Gorge
    - Vega Mountain Tributary in Roxbury
    - Floodplain bench enhancement alternatives in Grand Gorge
- Solicit feedback and answer questions from members of the public
- Outline the next steps for Roxbury to implement LFA recommendations

The meeting began with a summary recap of the LFA process, and its application to the hamlets of Grand Gorge and Roxbury. MMI first present the findings and recommendations for the hamlet of Roxbury. The public was particularly interested in the discussion surrounding Vega Mountain Tributary. A lot of valuable input was collected from residents and will be included in the final report. Afterwards, MMI presented alternatives and recommendations for Grand Gorge. Finally, MMI provided general recommendations regarding community flood resiliency.

The Draft LFA Report will be posted on the town of Roxbury website for the general public to view. FAC members, and residents of Roxbury and Grand Gorge alike, are encouraged to read this draft and provide input before it is finalized. Comments from the public should be directed to the Roxbury Town Board for synthesis and transmission to MMI. The report will be open for public feedback for the remainder of the month of December. Those who wish to provide comments are asked to please do so before the start of the 2020 year.

LOCAL FLOOD ANALYSIS - PUBLIC INFO MEETING

November 19, 2019 7:00 PM Town Hall

	Name		Telephone #
1	Thomas Hynes ✓	T/Roxbury Supervisor	607-326-7641
2	Edward Raeder ✓	T/Roxbury Town Board	
3	Allen Hinkley ✓	T/Roxbury Town Board	
4	~~Carol Murray~~	~~T/Roxbury Town Board~~	
5	Kenneth Davie ✓	T/Roxbury Town Board	
6	William Sprague ✓	T/Roxbury Dpty Hwy Supt	607-326-4222
7	Diane Pickett ✓	T/Roxbury Town Clerk	607-326-7641
8	Mark Carabetta ✓	MMI Engineers	845-633-8153
9	Miguel Castellanos ✓	MMI Engineers	845-633-8153
10	~~John Mathiesen~~	~~CWC~~	~~845-586-1400~~
11	Ben Dates ✓	DC Soil & Water	607-865-5223
12	Phil Eskeli ✓	NYCDEP	845-340-7853
13	~~Jim Thomas~~	~~DC DPW~~	~~607-832-5800~~
14	~~Sue McIntyre~~	~~DC DPW~~	~~607-832-5800~~
15	Richard Dykstra	Roxbury Property Owner	607 326-7101
16	Michel Dionne	Roxbury Resident	607 326-2984
17	Adam Trescott	NYC DEP	845-340-7220
18	Jane Piasek	Resident	607 326-4230
19	Sid Wallace	Resident	607-287-3981
20	Alan Davis	Roxbury Central	607 326 4151
21	Patrick Russell	Resident	917-226-4554
22	Jamie + Debbi Boyle	Roxbury	607-435-3829
23	Kevin DePadua	Rox.	607 792 6623
24	John Spartiosu	City. 41	
25			
26			
27			
28			
29			
30			
31			
32			
33			

APPENDIX B

Cost Opinion Calculations

Cost Analysis for Floodplain Enhancement Scenario 1
Park Lane along the Bear Kill in Grand Gorge, NY

Probable Construction Cost Estimate[1]				
Type	**Unit**	**QTY**	**Unit Cost**	**Cost**
Excavation Cost	C.Y.	9,210	$ 4	$ 36,840
Earthwork (export)	C.Y.	9,210	$ 20	$ 184,200
Tree Clearing	AC	0.50	$ 10,000	$ 5,000
Topsoil (0.5ft)	C.Y.	1,110	$ 25	$ 27,750
Seeding/Planting	S.F.	59,450	$ 2	$ 118,900
Design/Permitting	L.S.	1	$ 75,000	$ 75,000
Total Cost				$ 447,690
Construction Contingency (20%)[2]				**$ 537,000**

1 – Does not include cost of land acquisition or easements
2 - Rounded

Cost Analysis for Floodplain Enhancement Scenario 2
Behind Homes and Business on Route 23 along the Bear Kill in Grand Gorge, NY

Probable Construction Cost Estimate[1]				
Type	**Unit**	**QTY**	**Unit Cost**	**Cost**
Excavation Cost	C.Y.	6,130	$ 4	$ 24,520
Earthwork (export)	C.Y.	6,130	$ 20	$ 122,600
Tree Clearing	AC	0.30	$ 10,000	$ 3,000
Topsoil (0.5ft)	C.Y.	2,020	$ 25	$ 50,500
Seeding/Planting	S.F.	108,650	$ 2	$ 217,300
Design/Permitting	L.S.	1	$ 75,000	$ 75,000
Total Cost				$ 492,920
Construction Contingency (20%)[2]				**$ 592,000**

1 – Does not include cost of land acquisition or easements
2 - Rounded

Cost Analysis for Floodplain Enhancement Scenario under Bridge Street
East Branch Delaware River in Roxbury, NY

Probable Construction Cost Estimate[1]				
Type	**Unit**	**QTY**	**Unit Cost**	**Cost**
Excavation Cost	C.Y.	3,240	$ 4	$ 12,960
Earthwork (export)	C.Y.	3,240	$ 20	$ 64,800
Tree Clearing	AC	0.10	$ 10,000	$ 1,000
Topsoil (0.5ft)	C.Y.	340	$ 25	$ 8,500
Seeding/Planting	S.F.	18,080	$ 2	$ 13,560
Design/Permitting	L.S.	1	$ 75,000	$ 75,000
Total Cost				$ 175,820
Construction Contingency (20%)[2]				**$ 211,000**

1 – Does not include cost of land acquisition or easements
2 - Rounded

Cost Estimate for Replacement of Bridge Street Bridge
East Branch Delaware River in Roxbury, NY

Probable Construction Cost Estimate	
Engineering Design:	$100,000
Geotechnical Design:	$15,000
Permitting:	$15,000
Bridge Construction:	$2,500,000 to $3,500,000
Construction Inspection:	$250,000
Total:	$2,880,000 to $3,880,000
Contingency (20%)	**$3,546,000 to $4,656,000**

Notes and assumptions:

1. Assume concrete deck
2. 60 foot span
3. 3.0 mile detour required
4. Low risk of scour
5. Other bridge styles (i.e. a truss bridge) may generate lower cost
6. Does not include floodplain enhancement, easements, relocations of water and gravity sewer utilities on bridge

Engineer's Opinion of Probable Costs
Replacement of Vega Mountain Road Culvert at Johnson Road Intersection
12' x 5' Box Culvert
Roxbury/Grand Gorge Local Flood Analysis
Project No. 5197-15

ITEM DESCRIPTION	QTY	UNIT	UNIT COST	AMOUNT IN FIGURES
Culvert Work				
Removal of Existing Structure	1	LS	$ 30,000.00	$ 30,000.00
Structural Excavation	450	CY	$ 50.00	$ 22,500.00
Box Culvert - 12'W x 5'H	81	LF	$ 2,100.00	$ 170,100.00
Concrete (Abutments, Wingwalls, Curb)	10	CY	$ 1,500.00	$ 15,000.00
Reinforcing Steel	1250	LB	$ 3.00	$ 3,750.00
Select Structure Fill	225	CY	$ 50.00	$ 11,250.00
Subbase Course	40	CY	$ 50.00	$ 2,000.00
Membrane Waterproofing	110	SY	$ 90.00	$ 9,900.00
Roadway Work				
Bituminous Paving	40	TON	$ 250.00	$ 10,000.00
Double Box Beam Bridge Rail	32	LF	$ 150.00	$ 4,800.00
Transition Bridge Railing	128	LF	$ 120.00	$ 15,360.00
Channel Work				
Native Stream Bed Material	62	CY	$ 75.00	$ 4,650.00
Temporary Water Diversion Structure	1	LS	$ 15,000.00	$ 15,000.00
Miscellaneous				
Clearing and Grubbing (±2%)	1	LS	$ 7,000.00	$ 7,000.00
Maintenance and Protection of Traffic (±4%)	1	LS	$ 13,000.00	$ 13,000.00
Construction Staking (±1%)	1	LS	$ 3,200.00	$ 3,200.00
Mobilization (±7.5%)	1	LS	$ 24,000.00	$ 24,000.00
Minor Items (±15%)	1	LS	$ 48,000.00	$ 48,000.00
			Construction Subtotal =	$ 409,510.00
			Contingency (±20%) =	$ 81,902.00
			PROJECT SUBTOTAL =	$ 491,412.00
			PROJECT TOTAL (ROUNDED)=	**$ 491,000.00**

Engineer's Opinion of Probable Costs
Replacement of Vega Mountain Road Culvert
14' x 5' Box Culvert
Roxbury/Grand Gorge Local Flood Analysis
Project No. 5197-15

ITEM DESCRIPTION	QTY	UNIT	UNIT COST	AMOUNT IN FIGURES
Culvert Work				
Removal of Existing Structure	1	LS	$ 15,000.00	$ 15,000.00
Structural Excavation	450	CY	$ 50.00	$ 22,500.00
Box Culvert - 14'W x 5'H	30	LF	$ 2,300.00	$ 69,000.00
Concrete (Abutments, Wingwalls, Curb)	10	CY	$ 1,500.00	$ 15,000.00
Reinforcing Steel	1250	LB	$ 3.00	$ 3,750.00
Select Structure Fill	225	CY	$ 50.00	$ 11,250.00
Subbase Course	30	CY	$ 50.00	$ 1,500.00
Membrane Waterproofing	50	SY	$ 90.00	$ 4,500.00
Roadway Work				
Bituminous Paving	30	TON	$ 250.00	$ 7,500.00
Double Box Beam Bridge Rail	20	LF	$ 150.00	$ 3,000.00
Tranisition Bridge Railing	30	LF	$ 120.00	$ 3,600.00
Channel Work				
Native Stream Bed Material	750	CY	$ 75.00	$ 56,250.00
Temporary Water Diversion Structure	1	LS	$ 15,000.00	$ 15,000.00
Miscellaneous				
Clearing and Grubbing (±2%)	1	LS	$ 5,000.00	$ 5,000.00
Maintenance and Protection of Traffic (±4%)	1	LS	$ 10,000.00	$ 10,000.00
Construction Staking (±1%)	1	LS	$ 2,300.00	$ 2,300.00
Mobilization (±7.5%)	1	LS	$ 18,000.00	$ 18,000.00
Minor Items (±15%)	1	LS	$ 35,000.00	$ 35,000.00
			Construction Subtotal =	$ 298,150.00
			Contingency (±20%) =	$ 59,630.00
			PROJECT SUBTOTAL =	$ 357,780.00
			PROJECT TOTAL (ROUNDED)=	**$ 358,000.00**

Engineer's Opinion of Probable Costs
Replacement of NYS 30 Culvert and Channel Daylighting
16' x 4' Box Culvert
Roxbury/Grand Gorge Local Flood Analysis
Project No. 5197-15

ITEM DESCRIPTION	QTY	UNIT	UNIT COST	AMOUNT IN FIGURES
Culvert Work				
Removal of Existing Structure	1	LS	$ 20,000.00	$ 20,000.00
Box Culvert - 16'W x 4H	50	LF	$ 2,500.00	$ 125,000.00
Concrete (Abutments, Wingwalls, Curb)	15	CY	$ 1,500.00	$ 22,500.00
Reinforcing Steel	1875	LB	$ 3.00	$ 5,625.00
Select Structure Fill	225	CY	$ 50.00	$ 11,250.00
Subbase Course	75	CY	$ 50.00	$ 3,750.00
Membrane Waterproofing	95	SY	$ 90.00	$ 8,550.00
Roadway Work				
Bituminous Paving	90	TON	$ 250.00	$ 22,500.00
Double Box Beam Bridge Rail	35	LF	$ 150.00	$ 5,250.00
Transition Bridge Railing	120	LF	$ 120.00	$ 14,400.00
Channel Work & Daylight				
Native Stream Bed Material	2000	CY	$ 75.00	$ 150,000.00
Temporary Water Diversion Structure	1	LS	$ 15,000.00	$ 15,000.00
Removal of Existing Structures	1	LS	$400,000.00	$ 400,000.00
Miscellaneous				
Clearing and Grubbing (±2%)	1	LS	$ 13,000.00	$ 13,000.00
Maintenance and Protection of Traffic (±4%)	1	LS	$ 26,000.00	$ 26,000.00
Construction Staking (±1%)	1	LS	$ 6,400.00	$ 6,400.00
Mobilization (±7.5%)	1	LS	$ 48,000.00	$ 48,000.00
Minor Items (±15%)	1	LS	$ 95,000.00	$ 95,000.00

Construction Subtotal = $ 992,225.00

Contingency (±20%) = $ 198,445.00

PROJECT SUBTOTAL = $1,190,670.00

PROJECT TOTAL (ROUNDED)= $ 1,191,000.00