FLOOD MITIGATION & RESILIENCE REPORT

Minisceongo Creek - SD112

Prepared for:

New York State Department of Environmental Conservation,
in cooperation with the New York State Office of General Services

SLR #142.16511.00007.0040
April 2022

SLR

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New York State Department of Environmental Conservation,
in cooperation with the New York State Office of General Services
New York State Office of General Services
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Corning Tower, 35th Floor
Albany, New York 12242

NEW YORK STATE OF OPPORTUNITY. | Department of Environmental Conservation

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ACRONYMS

BFE	Base Flood Elevation
BIN	Bridge Identification Number
CFS	Cubic Feet per Second
DOW	Division of Water (NYSDEC)
DPW	Department of Public Works
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
fps	Feet per Second
GAIC	Garnerville Arts & Industrial Center
GEIS	Generic Environmental Impact Statement
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center – *River Analysis System*
HMP	Hazard Mitigation Plan
HRA	High Risk Area
LiDAR	Light Detection and Ranging
LWRP	Local Waterfront Revitalization Plan
mph	Miles per Hour
NAACC	North Atlantic Aquatic Connectivity Collaborative
NBI	National Bridge Inventory
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NWI	National Wetlands Inventory
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
NYSOGS	New York State Office of General Services
PIP	Palisades Interstate Parkway
PW	Planned Waterfront
RCP	Representative Concentration Pathways
R-W	Waterfront Residential
SDF	Spillway Design Flood
SEQRA	State Environmental Quality Review Act
SFHA	Special Flood Hazard Area
SIR	Scientific Investigations Report
SLR	SLR Engineering, Landscape Architecture, and Land Surveying, P>C.
STA	Station
TDR	Transfer of Development Rights
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

WPD	Waterfront Planned Development
WRIR	Water Resources Investigations Report
WSEl	Water Surface Elevation
WSP	Water Supply Paper

SUMMARY

This analysis of Minisceongo Creek is being conducted as part of the Resilient New York Program, an initiative of the New York State Department of Environmental Conservation. The main stem of Minisceongo Creek originates above Lake Welch in the town of Haverstraw and flows eastward along the town boundary between Haverstraw and Stony Point, through the village of West Haverstraw, and empties to the Hudson River Estuary. Tributaries include Horse Chock Brook, Beaver Pond Brook, and the South Branch of Minisceongo Creek. When measured at its outlet to the Hudson River Estuary, the Minisceongo Creek watershed is 19 square miles in size. The watershed has an irregular lobe shape, with one lobe extending westward to include Lake Welch and Breakneck Pond at the headwaters of Minisceongo Creek and another lobe extending southward into the town of Ramapo to include the South Branch of Minisceongo Creek.

Rockland County, including the Minisceongo Creek watershed, has an active history of flooding. According to National Oceanic and Atmospheric Administration (NOAA) historical records, 25 hurricane or tropical storm tracks have passed within 65 miles of Rockland County since 1861, with five passing directly through Rockland County. Based on stream flow records of peak flows from two nearby watercourses, it can be estimated that peak flows on Minisceongo Creek during the August 2011 Tropical Storm Irene were near or possibly exceeded the 100-year flood event.

As part of this analysis, flood-prone High Risk Areas, or HRAs, within the Minisceongo Creek watershed are identified, and an analysis of flood mitigation considerations within each HRA is undertaken. Factors with the potential to influence more than one HRA are also evaluated and discussed. An analysis of watershed land use is conducted, and a Flood Resiliency Best Practices Audit is conducted for each community within the watershed.

Flood mitigation scenarios such as floodplain enhancement and channel restoration, dam modifications, road closures, and replacement of undersized bridges and culverts are recommended where appropriate. At the Garnerville Arts & Industrial Center (GAIC) in Garnerville, removal of the floor slab of the upstreammost building spanning Minisceongo Creek is recommended. Recommendations for flood protection at individual properties are provided. A review of land use and zoning is conducted within the watershed towns and villages, and best practices are recommended.

1. INTRODUCTION

1.1 PROJECT BACKGROUND AND OVERVIEW

This work is a component of the Resilient New York Program, an initiative of the New York State Department of Environmental Conservation (NYSDEC), contracted through the New York State Office of General Services (NYSOGS). The goal of the Resilient New York Program is to make New York State more resilient to flooding and climate change. Through the program, flood studies are being conducted across the state, resulting in the development of flood and ice jam hazard mitigation alternatives to help guide implementation of mitigation projects.

Minisceongo Creek originates in west central Rockland County and drains eastward to the Hudson River Estuary. This report begins with an overview of the Minisceongo Creek watercourse and watershed, summarizes the history of flooding, and identifies High Risk Areas (HRAs) within the watershed. An analysis of flood mitigation considerations within each HRA is undertaken. Flood mitigation recommendations are provided either as HRA-specific recommendations or as overarching recommendations that apply to the entire watershed or stream corridor. Flood mitigation scenarios such as floodplain enhancement and channel restoration, road closures, and replacement of undersized bridges and culverts are investigated and are recommended where appropriate.

1.2 TERMINOLOGY

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. Stream stationing is used in the narrative and on maps as an address to identify specific points along the watercourse. Stationing is measured in feet and begins at station (STA) 0+00 where Minisceongo Creek empties into the Hudson River Estuary and continues upstream. As an example, Minisceongo Creek flows under the Palisades Interstate Parkway (PIP) at STA 330+00.

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 National Flood Insurance Program (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 level floodwaters are expected to reach in this event. For the purpose of this report, the 1 percent annual chance flood is also referred to as the 100-year flood. 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, FEMA has developed Flood Insurance Rate Mapping (FIRM), which indicates the location of the SFHA along Minisceongo Creek and its tributaries.

2. DATA COLLECTION

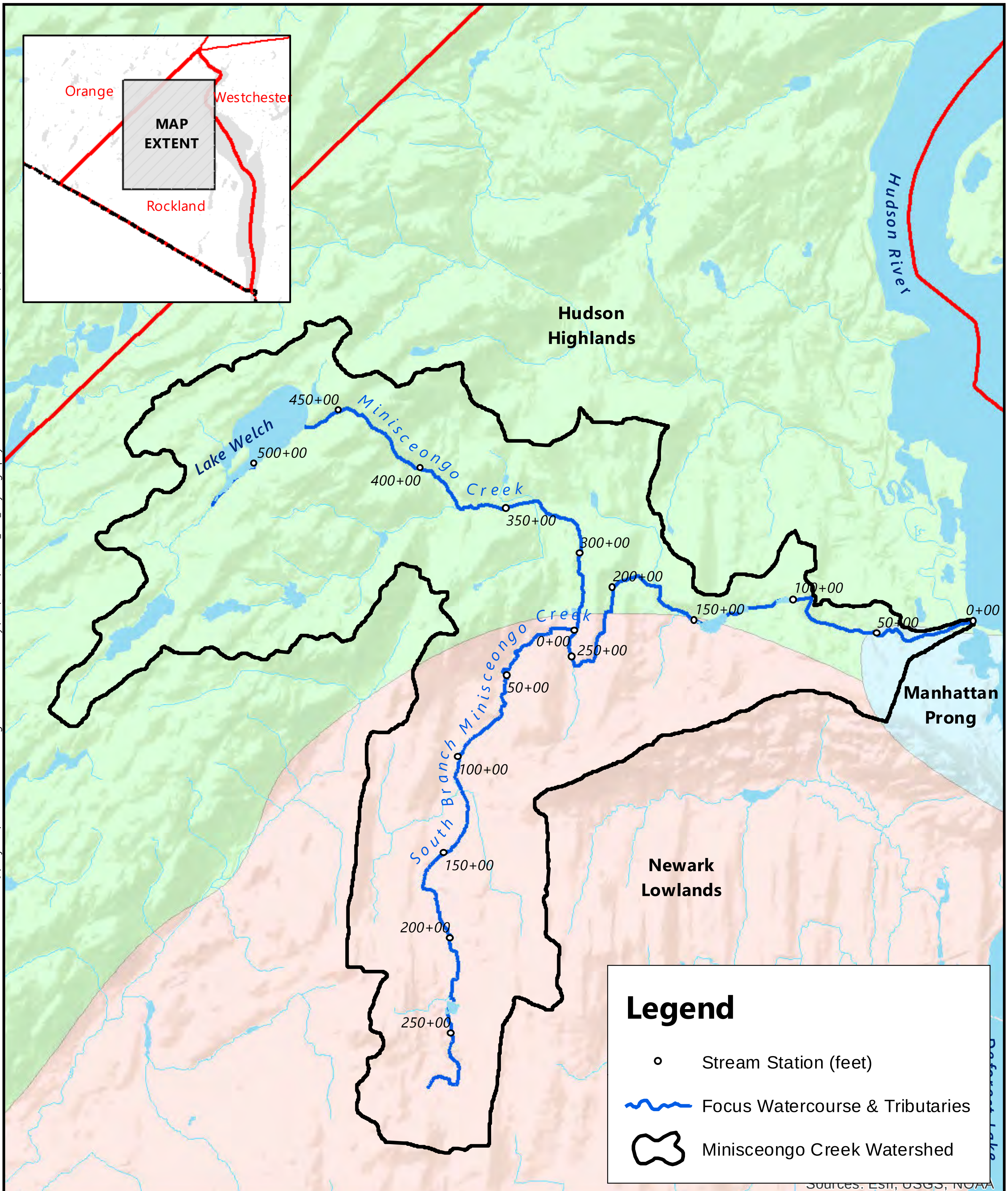
Data were gathered from various sources related to the hydrology and hydraulics of Minisceongo Creek and its tributaries, Minisceongo Creek watershed characteristics, recent and historical flooding in the affected communities, and factors that may contribute to flood hazards.

2.1 MINISCEONGO CREEK WATERSHED CHARACTERISTICS

The Minisceongo Creek watershed is located in Rockland County, in southeastern New York State. The southern portion of the watershed falls within the physiographic region of New York State known as the Newark Basin or Newark Lowlands while the higher lands in the northern and western portions of the watershed fall within the Hudson Highlands physiographic region (Figure 2-1). The watershed has an irregular, lobed shape, with one lobe extending westward to include Lake Welch and Breakneck Pond at the headwaters of Minisceongo Creek and another lobe extending southward to include the South Branch of Minisceongo Creek. When measured at its outlet to the Hudson River Estuary, the Minisceongo Creek watershed is 19 square miles in size. Figure 2-2 is a watershed map. Figure 2-3 is a relief map of the watershed.

The southern portion of the Minisceongo Creek watershed is underlain by bedrock that is classified as part of the Newark Group. Bedrock within this group dates from the Upper Triassic and has been mapped as distinct formations, including the Brunswick and Hammer Creek Formations. Forming the southern boundary of the lower watershed is Palisades Diabase, an igneous rock type containing light feldspar and dark augite, which give the rock a distinctive "salt-and-pepper" appearance. The northern portion of the watershed is underlain by metamorphic rock including Hornblende granite and granite gneiss dating from the Middle Proterozoic. Bands of bedrock that run along the western portion of watershed are mapped as quartz plagioclase, also dating from the Middle Proterozoic. The very western portion is mapped as interlayered amphibolite and hornblende granitic gneiss.

Surficial materials underlying the Minisceongo Creek watershed consist primarily of glacial till, with areas mapped as exposed bedrock occurring along the southern boundary of the lower watershed (the area mapped as Palisades Diabase bedrock) and at other locations within the watershed. Areas mapped as outwash sand and gravel underlie the valley bottom in the central and southern portions of the watershed, underlying the South Branch of Minisceongo Creek. Alluvium underlies the Minisceongo Creek valley bottom in the lower watershed.



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PHYSIOGRAPHIC REGIONS

MINISCEONGO CREEK FLOOD & RESILIENCY STUDY
SD112
ROCKLAND COUNTY
NEW YORK

N

0 2,500 5,000
Feet

SCALE 1 " = 6,000 '

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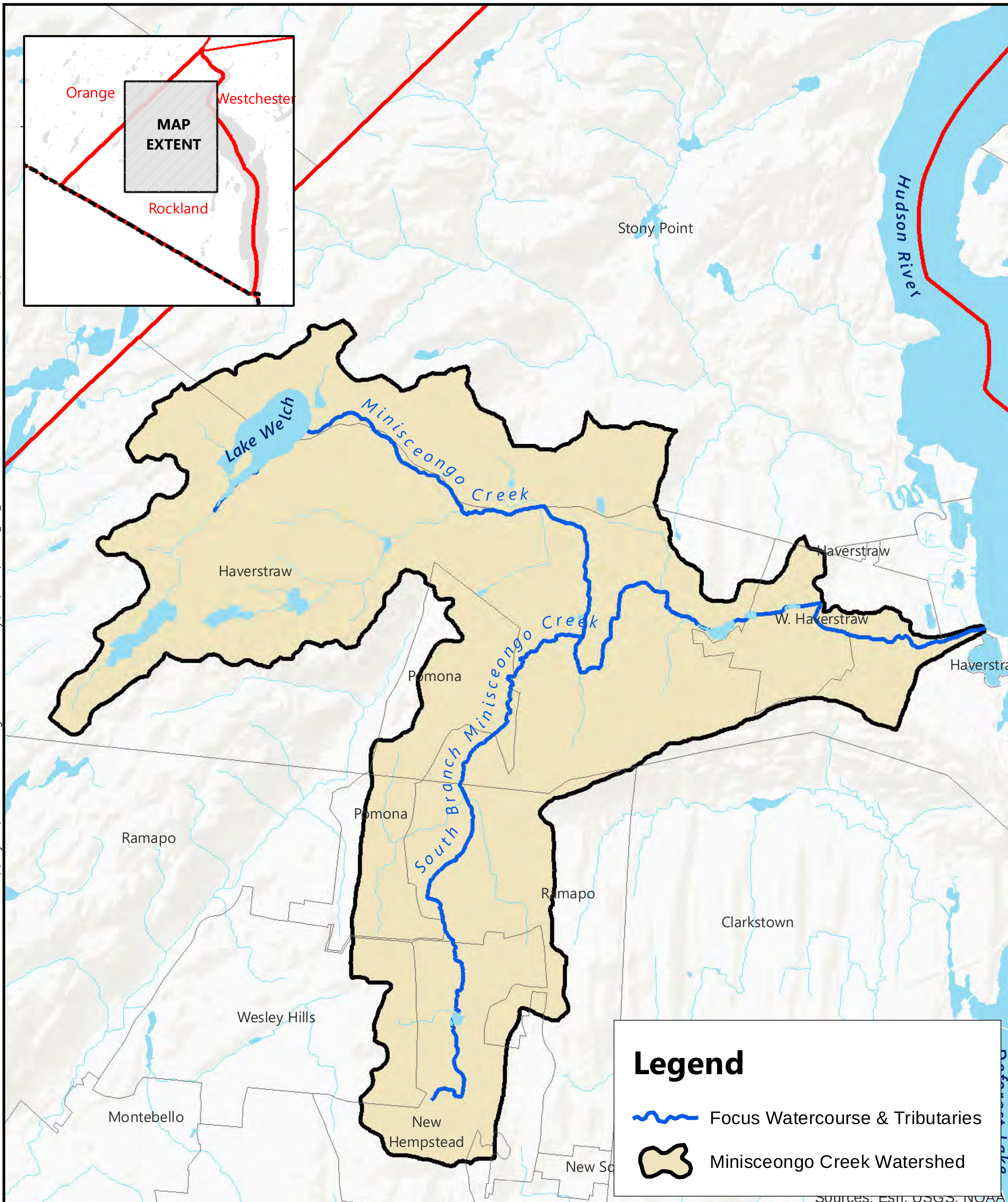
FIG. 2-1



Document Path: Q:\Projects\6511-07 Minisceongo Creek Flood Study\GIS\MXD\FIG.2-2_MC_Watershed.mxd Date Saved: 7/16/2021 Copyright SLR Consulting - 2022

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MINISCEONGO CREEK WATERSHED

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SD112

ROCKLAND COUNTY
NEW YORK

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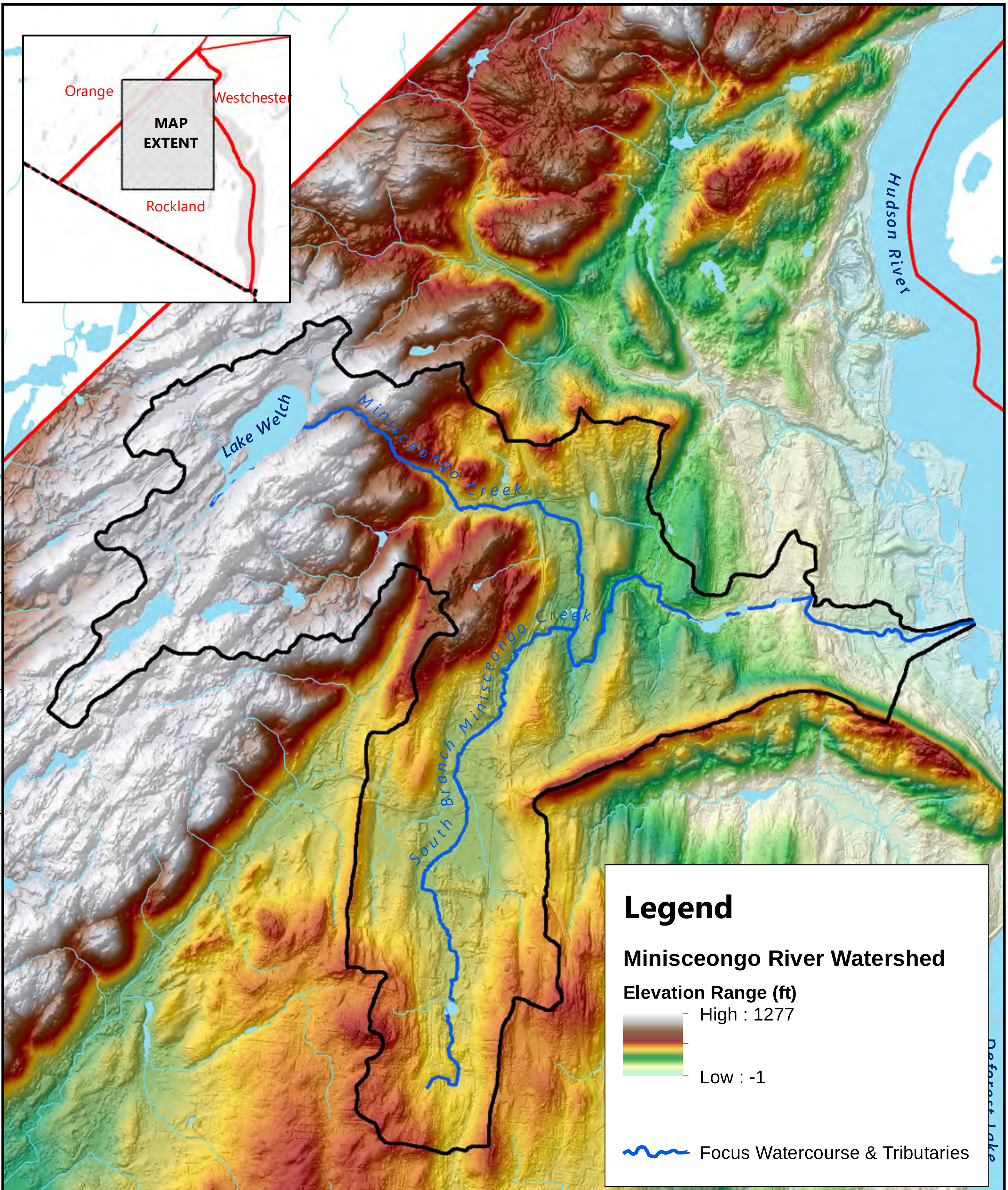
FIG. 2-2



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RELIEF MAP

MINISCEONGO CREEK FLOOD & RESILIENCY STUDY
SD112
ROCKLAND COUNTY
NEW YORK

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Feet

SCALE 1 " = 6,000 '

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FIG. 2-3

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During a rainfall event, the proportion of rainfall that runs off directly into rivers and streams or that infiltrates into the ground is greatly influenced by the composition of soils within a watershed. Soils are assigned a hydrologic soil group identifier, which is a measure of the infiltration capacity of the soil. These are ranked A through D. A hydrologic soil group 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. Figure 2-4 depicts the hydrologic soil groups present in the Minisceongo Creek watershed. The hydrologic soil group B is most prevalent, followed by the hydrologic soil group C. Combined, these two hydrologic soil groups make up 77 percent of the watershed.

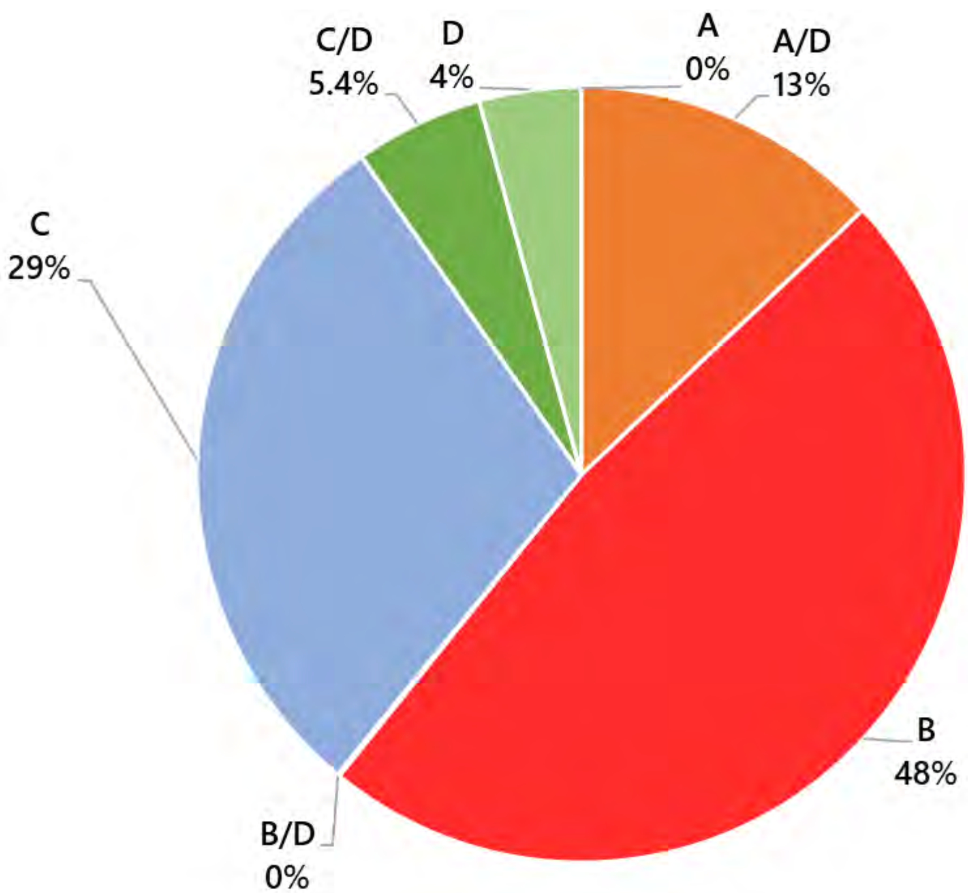

Figure 2-4: Hydrologic Grouping of Soils within the Minisceongo Creek Watershed

Land cover is another important factor influencing the runoff characteristics of a watershed. Rockland County is located a dozen miles north-northwest of New York City and is part of the New York Metropolitan Area. Land cover within the Minisceongo Creek watershed can be characterized using the 2016 Multi-Resolution Land Characteristics National Land Cover Database for Southeast New York State and is shown graphically in Figure 2-5. Developed land is the most common land cover, representing 46 percent of the watershed. Forested land consists of deciduous, coniferous, and mixed forest types and makes up 45 percent of the land cover in the watershed. Open water and wetlands combined make up 6 percent of the land cover. The remaining 3 percent of the land cover consists of agricultural land, grassland and shrubland, and barren land.

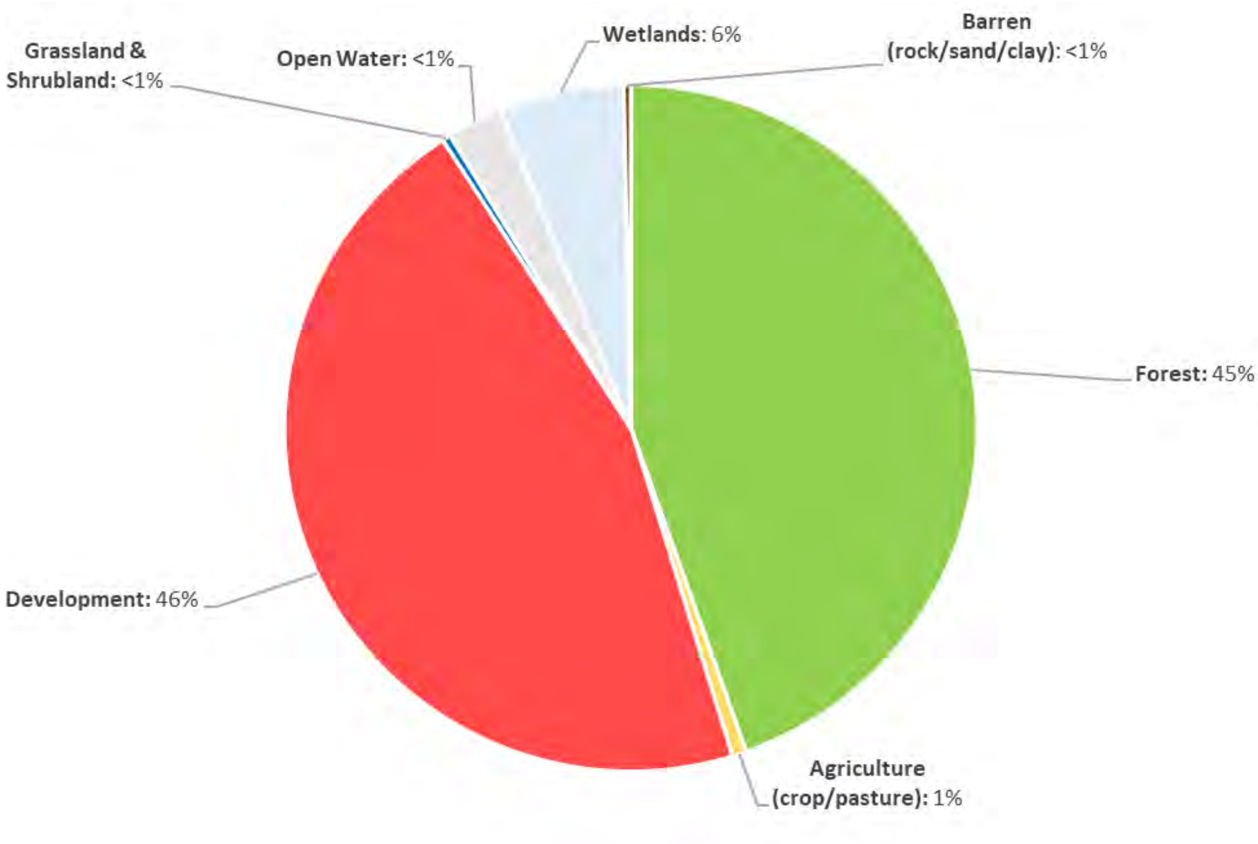

Figure 2-5: Land Cover within the Minisceongo Creek Watershed

Wetland cover was also examined using information available from the U.S. Fish & Wildlife Service's National Wetlands Inventory (NWI). The NWI indicates that there are 38,978 acres of wetlands in the Minisceongo Creek watershed, or approximately 7.7 percent of the watershed. This amount is larger than the estimated amount of wetlands above based on land cover and includes the following types of wetland habitats: freshwater forest/shrub wetland, freshwater emergent wetland, freshwater lakes and ponds, and riverine wetland.

It is estimated that since colonial times approximately 50 to 60 percent of the wetlands in the state of New York have been lost through draining, filling, and other types of alteration.

Wetlands play an important role in flood mitigation by storing water and attenuating peak flows. It is estimated that since colonial times approximately 50 to 60 percent of the wetlands in the state of New York have been lost through draining, filling, and other types of alteration.

Mount Ivy Swamp, a 410-acre NYSDEC-mapped wetland complex along South Branch Minisceongo Creek in the towns of Ramapo and Haverstraw, is pictured in Figure 2-6. Green Swamp, Grape Swamp, and other wetlands associated with Lake Welch are located near the headwaters of Minisceongo Creek.

The watershed has several waterbodies including Breakneck Pond; First, Second, and Third Reservoirs; Lake Welch; Cheesecoat Pond; and Gurnee Lake. There are smaller ponds throughout the watershed.

Figure 2-6: Mount Ivy Swamp, a 410-acre NYSDEC-mapped wetland complex along South Branch Minisceongo Creek in the towns of Ramapo and Haverstraw

2.2 MINISCEONGO CREEK WATERCOURSE

The main stem of Minisceongo Creek originates above Lake Welch in the town of Haverstraw and flows generally eastward along the town boundary between Haverstraw and Stony Point. The watercourse bends southward at the hamlet of Willow Grove and then turns sharply northward before turning eastward again at Thiells and through the village of West Haverstraw. It continues eastward into Haverstraw before emptying to the Hudson River Estuary. Named tributaries to the main stem include Horse Chock Brook, Beaver Pond Brook, and the South Branch of Minisceongo Creek.

Stream order provides a measure of the relative size of streams by assigning a numeric order to each stream in a stream network. The smallest tributaries are designated as first-order streams, and the designation increases as tributaries join. The main stem of Minisceongo Creek can be characterized as a fourth-order stream from where it is joined by the South Branch of Minisceongo Creek downstream to its outlet where it discharges to the Hudson River Estuary. Figure 2-7 is a map depicting stream order in the Minisceongo Creek watershed.

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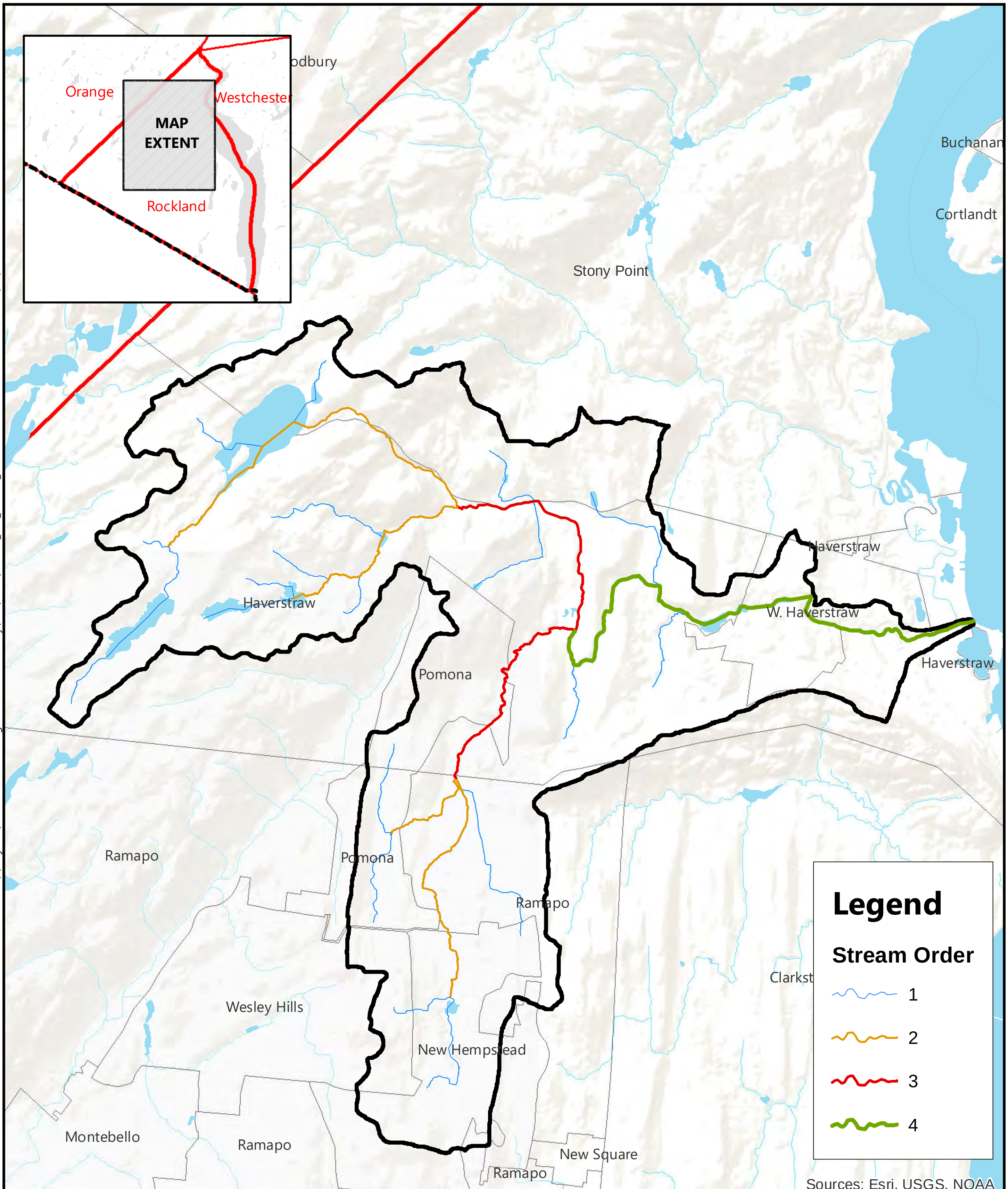

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WATERSHED STREAM ORDER

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ROCKLAND COUNTY
NEW YORK

N

0 2,500 5,000
Feet

SCALE 1 " = 6,000 '

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FIG. 2-7

Characteristics of each order of stream (total length, average slope, and percentage of overall stream network) are summarized in Table 2-1. First- and second-order streams account for most of the overall stream length within the Minisceongo Creek watershed (74 percent). First- and second-order streams are steeper in slope than third- and fourth-order streams.

Table 2-1: Stream Order Characteristics in the Minisceongo Creek Watershed

Stream Order	Total Length (miles)	Percentage of Overall Network Length (%)	Average Slope (%)
1st	17.1	49	2.2
2nd	8.6	25	2.2
3rd	4.2	12	0.9
4th	5.0	14	1.5
Total	**34.9**	**100**	

2.3 HYDROLOGY

Hydrologic studies are conducted to understand historical, current, and potential future river flow rates, which are a critical input for hydraulic modeling software such as *Hydrologic Engineering Center – River Analysis System* (HEC-RAS). These often include statistical techniques to estimate the probability of a certain flow rate occurring within a certain period of time based on data from the past; these data are collected and maintained by the United States Geological Survey (USGS) at thousands of stream gauging stations around the country. For the streams without gauges, the USGS has developed region-specific regression equations that estimate flows based on watershed characteristics such as drainage area and annual precipitation, as well as various techniques to account for the presence of nearby stream gauges or to improve analyses of gauges with limited records. These are based on the same watershed characteristics as gauged streams in that region so are certainly informative although not as accurate or reliable as a gauge due to the intricacies of each unique basin.

For the purposes of this study, we are primarily concerned with the more severe flood flows although hydrologic analyses may be conducted for the purposes of estimating low flows, high flows, or anywhere in between. The commonly termed "100-Year Flood" refers to the flow rate that is predicted to have a 1 percent, or 1 in 100, chance of occurring in any year. A "25-Year Flood" has a 1 in 25 chance of occurring (4 percent) every year. It is important to note that referring to a specific discharge as an "X-Year Flood" is a common and convenient way to express a statistical probability but can be misleading because it has no bearing whatsoever on when or how often such a flow actually occurs.

Flood hydrology for the main stem of Minisceongo Creek was gleaned from the effective Flood Insurance Study (FIS) for Rockland County (36087CV001A). Discharge estimates at five locations along the creek are reported for the 10-, 50-, 100-, and 500-Year floods based on regional regression equations developed for New York State detailed in USGS Scientific Investigations Report (SIR) 2006-5112, as well as the urban runoff regressions defined in USGS Water Supply Paper (WSP) 2207. Flood flows on the South Branch of Minisceongo Creek were obtained from the FIS as well. Flood flows on Minisceongo Creek and its South Branch are presented in Table 2-2 and 2-3, respectively.

Along with the location, duration, and intensity of a storm, the flooding that may result from a rainfall event can vary widely depending on the unique hydrology of each basin. Characteristics of local topography, soils, vegetation cover and type, bedrock geology, land use and cover, river hydraulics and floodplain storage, ponding, wetland, and reservoir storage, combined with antecedent conditions in the watershed such as snowpack or soil saturation, can impact the timing, duration, and severity of flooding.

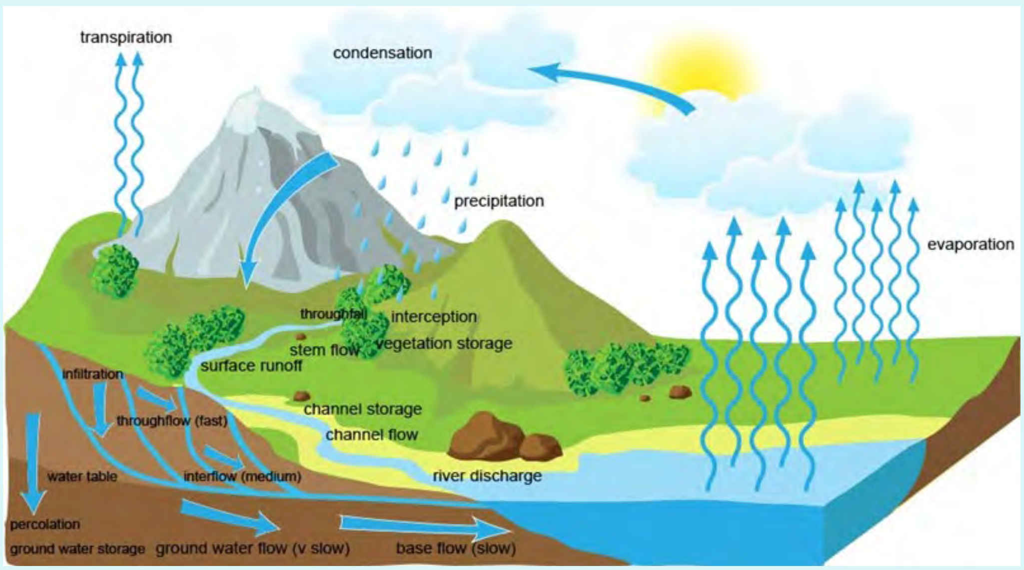


Figure 2-8: Diagram of Simplified Hydrologic Cycle

Table 2-2: Flood Hydrology for Minisceongo Creek Developed for the Rockland County FIS (36087CV001A)

Location	Drainage Area (sq. mi.)	Peak Flood Discharge (cfs)			
		10-Year	50-Year	100-Year	500-Year
At town and village of Haverstraw and village of West Haverstraw corporate limits	18.54	2,158	3,539	4,367	6,576
Village of Haverstraw – village of West Haverstraw corporate limits	17.84	2,045	3,365	4,139	6,250
At town and West Haverstraw corporate limits	16.77	1,887	3,097	3,815	5,753
Approximately 430 feet downstream of Rosman Road	14.69	1,580	2,595	3,188	4,818
Downstream of confluence with South Branch Minisceongo Creek	13.59	1,386	2,295	2,823	4,290

Table 2-3: Flood Hydrology for South Branch Minisceongo Creek Developed for the Rockland County FIS (36087CV001A)

Location	Drainage Area (sq. mi.)	Peak Flood Discharge (cfs)			
		10-Year	50-Year	100-Year	500-Year
At confluence with Minisceongo Creek	6.20	325	545	660	1,010
At village of Pomona – town of Haverstraw corporate limits	5.74	300	500	610	935
At Quaker Road	5.35	295	495	600	920
At Haverstraw/Ramapo corporate limits	4.70	275	455	560	855

The web-based tool "Application of Flood Regressions and Climate Change Scenarios to Explore Estimates of Future Peak Flows" developed by the USGS (Burns et al., 2015a,b) was used to obtain estimates for changes to peak-flood flows under a range of projected climate change scenarios at different periods in the future. This tool is currently only available for New York State and was used to assess flooding conditions that may occur in future decades, enabling proactive flood mitigation measures. These may include restricting development in areas that are not currently regulated floodplains but are reasonably expected to be in the future based on climate change projections or identifying bridges and culverts that currently perform well but may become hydraulically inadequate in the future.

Precipitation data were evaluated for two future scenarios, termed "Representative Concentration Pathways" (RCP), that provide estimates of the extent to which greenhouse gas concentrations in the atmosphere are likely to change through the 21st century. RCP refers to potential future emissions trajectories of greenhouse gases such as carbon dioxide. RCP 4.5 is considered a midrange-emissions scenario, and RCP 8.5 is a high-emissions scenario. Resulting precipitation and runoff estimates are based on five different climate models and are input into the USGS *StreamStats* program, a web-based implementation of regional hydrologic regression equations. Percent increases over *StreamStats* regression estimates based on current climatic data, as computed for the Minisceongo Creek watershed, were applied to corresponding design flood flows used in hydraulic modeling of the stream and its tributaries. The flows based on the more moderate greenhouse gas scenario for the upcoming 25-year period (2025-2049) were used in the model. Mean estimated increases for the 50- and 100-year floods based on the five climate models are presented in Table 2-4. These are based on regressions for Flood Frequency Region 2 in New York. Current and predicted future flows are compared in Table 2-5.

Table 2-4: Projected Increases in Flood Flows on Minisceongo Creek at Confluence with Hudson River

Mean Change in discharge (%)	2025-2049		2050-2074		2075-2099	
Greenhouse Gas Scenario	50-Year Flood	100-Year Flood	50-Year Flood	100-Year Flood	50-Year Flood	100-Year Flood
RCP 4.5	15	15	18	19	16	17
RCP 8.5	15	15	16	17	22	23

Table 2-5: Current and Projected Future Design Flood Flows Used in Hydraulic Analyses on Minisceongo Creek

Location	Peak Flood Discharge (cfs)			
	Current		Projected Future	
	50-Year	100-Year	50-Year	100-Year
At town and village of Haverstraw and village of West Haverstraw corporate limits	3,539	4,367	4,070	5,023
Village of Haverstraw – village of West Haverstraw corporate limits	3,365	4,139	3,870	4,760
At town and West Haverstraw corporate limits	3,097	3,815	3,562	4,388
Approximately 430 feet downstream of Rosman Road	2,595	3,188	2,985	3,667
Downstream of confluence with South Branch Minisceongo Creek	2,295	2,823	2,640	3,247

Hudson River flood elevation estimates were obtained from the effective FIS for Rockland County, shown in Table 2-6. Projected sea level rise in the estuary was based on New York State Sea-level Rise Projections (6 NYCRR Part 490) that were developed in accordance with the Community Risk and Resiliency Act to help prepare for the coastal impacts of climate change. Projected increases in sea level in the Hudson River Estuary within the "Lower Hudson" region, where Minisceongo Creek is located, are reproduced below as Table 2-7. These are predicted increases over the baseline of the average elevation measured from 2000 to 2004. Several scenarios are possible, ranging from less to more severe, however, "while there is some uncertainty regarding the precise rate at which sea level will rise, there is relative certainty that global sea level will ultimately rise at least six feet over current levels" (6 NYCRR Part 490). Therefore, Hudson River tailwater elevations used in hydraulic modeling of future flood scenarios on Minisceongo Creek were increased by a conservative 6 feet over the elevations reported in the current effective FIS.

Table 2-6: Stillwater Flood Elevations in Hudson River Estuary as Reported in FIS for Rockland County

Flood Event	Stillwater Flood Elevations (feet, NAVD88)
10-Year	5.1
50-Year	6.1
100-Year	6.7
500-Year	7.9

Table 2-7: New York State Sea-Level Rise Projections, Lower Hudson River Estuary (from 6 NYCRR 490)

	Projected Sea Level Rise in the Lower Hudson/NYC Region (inches)				
Projection Scenario	Low	Low-Medium	Medium	High-Medium	High
2020s	2	4	6	8	10
2050s	8	11	16	21	30
2080s	13	18	29	39	58
2100	15	22	36	50	75

2.4 HYDRAULICS

Flooding along approximately 6.5 miles of Minisceongo Creek, between the PIP and the Hudson River, was modeled using the *Surface-water Modeling System* (SMS, v. 13.1; Aquaveo 2021) commercial graphical interface for the US Bureau of Reclamation's two-dimensional *Sedimentation and River Hydraulics* numerical solver (SRH-2D, v. 3.3.1; USBR 2020). This software solves the numerically discretized St. Venant shallow water approximations to the three-dimensional Navier-Stokes equations for fluid flow. Water surface elevations, flow depths, and velocities are computed across a two-dimensional network of cells upon a three-dimensional terrain surface. Boundary drag is computed based on Manning's roughness coefficients applied to the terrain.

FEMA hydraulic modeling for Minisceongo Creek above its confluence with the South Branch Minisceongo Creek, and for the South Branch Minisceongo Creek, is based on antiquated HEC-2 analysis dating from the 1980s and was not used for this analysis.

Smaller tributaries to Minisceongo Creek were modeled with the Federal Highway Administration's *HY-8 Culvert Hydraulics Analysis Program* (Version 7.60; FHWA 2019). This software uses several input parameters to perform hydraulic calculations for structures but with limited contextual data relative to the surrounding stream. For this reason, these models are relatively simple and useful for approximate sizing of culverts but are not substitutes for complete hydraulic analyses of proposed culvert upgrades, especially if projects are expected to impact flow dynamics beyond their immediate vicinity.

2.4.1 EXISTING CONDITIONS MODELING

Two-dimensional model geometry was based on a combination of surveyed channel cross sections included in effective FEMA modeling, field measurements by SLR Engineering, Landscape Architecture, and Land Surveying, P.C. (SLR), and Light Detection and Ranging (LiDAR)-derived topographic mapping collected in 2014 available from the New York State (NYS) Geographic Information System (GIS) Program. The approximately 1,000-acre model domain comprises approximately 100,000 computational nodes, which define some 180,000 triangular and rectangular mesh elements. Steady state flows for Minisceongo and its South were based on hydrology reported in the effective FIS. Downstream increases in discharge represented by change points in FEMA modeling were associated with unnamed tributaries, where inflow was applied to the model with additional boundary conditions. Internal pressure boundary conditions were applied at 13 bridge and culvert crossings as well as two buildings that span the creek at the GAIC. One of these buildings, known as building number 5, is currently in use. The five dams and weirs along this stretch of Minisceongo Creek were incorporated into the mesh geometry. Structure dimensions were gleaned from FEMA modeling or were measured in the field. Manning's roughness coefficients were assigned based on land cover as determined by aerial imagery and field reconnaissance; values were based on assessment of onsite conditions, literature guidance (e.g., Chow 1959, USGS WSP 2339, USGS Water Resources Investigations Report [WRIR] 83-4247), past modeling efforts, and engineering judgment.

For HY-8 models, culvert geometry, including dimensions of the hydraulic opening, barrel material, slope, and inlet configuration, as well as roadway embankment characteristics and stream channel profile and cross sections were measured in the field. Culvert capacity and potential roadway overtopping were then assessed.

2.4.2 PROPOSED CONDITIONS MODELING

Several SMS/SRH-2D model geometries were developed to represent proposed conditions in order to assess alternatives at the identified HRAs on Minisceongo Creek. These involved modifications of the terrain, computational mesh, structures, boundary conditions, surface roughness, or combinations thereof. Flood mitigation alternatives were modeled individually and in combination to assess practical and effective short- and long-term solutions.

In HY-8 models, culvert geometry and characteristics were adjusted iteratively to determine configurations that would be adequate to convey design floods.

2.5 STAKEHOLDER MEETINGS

An important component of the data gathering for this study took place through stakeholder engagement. Two formal stakeholder meetings were convened by video conference call. The first meeting was held on December 15, 2020. This meeting was geared toward participation by government agencies, county, and municipal staff and included participation from NYSDEC, OGS, and County of Rockland. The second meeting was held on the evening of February 4, 2021, with participation from members of watershed groups. In addition to the formal video conferences, many one-on-one conversations took place with representatives from the watershed municipalities, business owners, government agencies, and advocacy groups. A wrap-up meeting was held on February 22, 2022, to share the findings and recommendations provided in this flood study report.

2.6 INFRASTRUCTURE

Several bridge and culvert crossings of Minisceongo Creek and its South Branch are contained within identified High Risk Areas and in certain cases may contribute to flooding in these locations. These structures and summary details are listed below in Table 2-8. A number of additional structures span the stream and were modeled but were not assessed in detail generally because they were adequate or did not significantly increase the flood hazard in the surrounding areas.

Table 2-8: Summary Data for Assessed Bridge and Culvert Crossings of Minisceongo Creek and South Branch Minisceongo Creek

Watercourse	Roadway	Structure	NBI BIN	River Station (feet)	Number of Spans/ Barrels	Total Span (feet)	Rise Above Streambed (feet)	Bankfull Width (feet) (Regional Regressions)
Minisceongo Creek	Route 9W	Conc. Box Culverts	1007130	67+00	2	20	10	56
	Bridge Street	Steel Beam Bridge	3345870	100+80	1	62	12	55
	4WD Rd/DPW Access	Conc. Box Culverts	Not Listed	245+00	2	28	8	53
	Rockland Print Co. Power Plant Access	Cast-in-Place Conc. Bridge	Not Listed	293+00	3	70	7	44
	Storrs Road	Steel Beam Bridge	5521530	306+00	1	37	8	44

Watercourse	Roadway	Structure	NBI BIN	River Station (feet)	Number of Spans/ Barrels	Total Span (feet)	Rise Above Streambed (feet)	Bankfull Width (feet) (Regional Regressions)
	Palisades Parkway Exit 14 Northbound Ramp	Conc. Arch Bridge	1068950	330+00	1	24	8	43
	Call Hollow Road	Conc. Box Culverts	3345900	360+00	2	34	8	41
South Branch Minisceongo Creek	US 202	Conc. Box Culverts	Not Listed	118+00	2	16	4.5	31
	South Camp Hill Road	Round CMP Culverts	Not Listed	183+50	3 x 5-ft diameter CMP			30
	South Camp Hill Road	Round CMP Culverts	Not Listed	190+00	3 x 5-ft diameter CMP			29

3. IDENTIFICATION OF FLOOD HAZARDS

3.1 FLOODING HISTORY

Rockland County has an active history of hurricanes and tropical storms. According to NOAA historical records summarized in the FEMA FIS for Rockland County, 25 hurricane or tropical storm tracks have passed within 65 miles of Rockland County since 1861, including four Category 1 hurricanes, two Category 2 hurricanes, and 19 tropical storms. Of the 25 recorded storm events, five passed directly through Rockland County. Table 3-1 is a summary of flood events that impacted Rockland County and the Minisceongo Creek watershed. The flood history is summarized from the FEMA FIS for Rockland County and the Rockland County Multi-Jurisdictional Hazard Mitigation Plan.

Table 3-1: Minisceongo Creek Flood History

Date	Flood Event	Notes
1863 to 1915	Four unnamed tropical storms	
1972	Tropical Storm Agnes	
September 1975	Hurricane Eloise	Rockland County was included in areas eligible for both Individual and Public Assistance under Disaster Declaration DR-0487, following the impacts of the remnants of Hurricane Eloise. Heavy rainfall caused riverine flooding and an estimated $300 million in damage across the northeastern United States.
1988	Tropical Depression	
December 21, 1992	Nor'easter	This nor'easter, which caused widespread flooding and damage to commercial and residential properties, utilities, roads, and other infrastructure, resulted in Disaster Declaration 0974, under which Rockland County became eligible for both Public and Individual Assistance.
July 13, 1996	Hurricane Bertha	Hurricane Bertha originally made landfall in North Carolina but had weakened to a Tropical Storm by the time it reached the New York City area. It passed Long Island, producing torrential rain and strong gusty winds. Torrential rain caused flooding of low-lying and poor-drainage areas, streams, and rivers across the area. The heaviest rain fell in a band to the northwest of Bertha's track over the Lower Hudson Valley. The Mahwah River at Suffern in Rockland County rose above its 4-foot flood stage from 11:30 a.m. EST on July 13 through 10:15 a.m. on July 14. The crest stage was 5.75 feet at 1:15 p.m. on July 13. The Saw Mill River in Westchester County also flooded. Rainfall amounts recorded in Rockland County ranged from 3.25 inches at West Nyack to 4.65 inches at Pomona.

Date	Flood Event	Notes
September 1999	Remnants of Hurricane Floyd	Tropical Depressions by the time it reached Rockland County. Widespread flooding in Rockland, Orange, Putnam, and Westchester Counties; total damage costs estimated at $14.6 million. Rainfall amounts from 3.16 inches at Nanuet to 3.31 inches at New City.
September 2004	Hurricane Ivan	Tropical Depressions by the time it reached Rockland County
April 15-16, 2007	Nor'easter	A nor'easter occurred during Sunday and Monday, April 15 and 16, which brought heavy rain and high winds that caused widespread and significant river, stream, and urban flooding of low-lying and poor-drainage areas. Rockland County was among the counties eligible for Individual and Public Assistance under the resulting Federal Disaster Declaration DR-1692. Costs to repair disaster damages to roads and drainage structures in Rockland County were estimated at $5,000,000.
June 2007		Extreme tributary flash flooding Up to 10"+ of rain fell in ~3 hours. Damage to Routes 207/7 Town of Colchester reported over $7.5M in damages.
September 2008	Tropical Storm Hanna	Tropical Depressions by the time it reached Rockland County

Date	Flood Event	Notes
August and September, 2011	Tropical Storm Irene and Tropical Storm Lee	Hurricane Irene formed from a tropical wave on August 21, 2011, in the tropical Atlantic Ocean. It moved west-northwestward, and before becoming a hurricane, Irene struck Puerto Rico as a tropical storm. Hurricane Irene steadily strengthened to reach peak winds of 120 miles per hour (mph) on August 24. Irene then gradually weakened and made landfall on the Outer Banks of North Carolina with winds of 85 mph on August 27. It slowly weakened over land and re-emerged into the Atlantic on the following day. Later on August 28, Irene was downgraded to a tropical storm and made two additional landfalls, one in New Jersey and another in New York. Irene produced heavy damage over much of New York, totaling $296 million. The storm is ranked as one of the costliest in the history of New York, after Hurricane Agnes in 1972. Much of the damage occurred due to flooding, both from heavy rainfall in inland areas and storm surge in New York City and on Long Island. Tropical storm force winds left at least 3 million residents without electricity in New York and Connecticut. Ten fatalities are directly attributed to the hurricane. $296 million in damages across New York State, 7.52 inches of rainfall recorded at Tappan, New York Over 30,000 people were affected by boil water notices in Rockland County from both Hurricane Irene and Tropical Storm Lee. A total of five wastewater and sewage treatment facilities experienced overflow, bypass, or inundation during Hurricane Irene. Over 30 facilities in NYS released untreated wastewater into tributaries or the Hudson itself. Rockland County had three municipalities with 67 percent to 90 percent of its residents without power as of 8:30 a.m. on August 29, 2011. Twenty-three municipalities had 34 percent to 66 percent of their residents without power. The rest of the municipalities in the county either had 11 percent to 33 percent or 1 percent to 10 percent of their people without power. According to direct measures compiled by the Hudson River Estuary Program and NYSDEC, the costs from Hurricane Irene and Tropical Storm Lee amounted to $27,909,828.44 in Rockland County. That includes estimated storm recovery costs, expenditures from Project Hope (crisis counseling for residents impacted by Hurricane Irene), FEMA individual assistance aid, and costs of spill response and cleanup.

Date	Flood Event	Notes
October 29, 2012	Superstorm Sandy	Hurricane Sandy was the deadliest and most destructive hurricane of the 2012 Atlantic hurricane season, as well as the second-costliest hurricane in United States history. Classified as the eighteenth named storm, tenth hurricane, and second major hurricane of the year, Hurricane Sandy made landfall in the United States about 8 p.m. EDT October 29, striking near Atlantic City, New Jersey, with winds of 80 mph. A full moon made high tides 20 percent higher than normal and amplified Sandy's storm surge. Hurricane Sandy affected 24 states, including the entire eastern seaboard from Florida to Maine and west across the Appalachian Mountains to Michigan and Wisconsin, with particularly severe damage in New Jersey and New York. Its storm surge hit New York City on October 29, flooding streets, tunnels, and subway lines and cutting power in and around the city. Damage in the US is estimated at over $100 billion (2013 USD). Record coastal flooding in Lower New York. Towns of Stony Point and Piermont sustained major damage. In the village of Piermont, approximately 300 individuals were evacuated from homes and businesses.

There are no active USGS stream gauges on Minisceongo Creek. Annual peak flow on the nearby Hackensack River, recorded at Rivervale, New Jersey, since 1942 at USGS gauge (01377000), provides a useful view of flood events. Figure 3-1 is a hydrograph showing annual peak flows recorded. Flood recurrence information from the FEMA FIS showing the magnitude of the 10-, 50-, and 100-year flood events has been superimposed on the hydrograph. Two flood events stand out: the April 2007 nor'easter and the August 2011 Tropical Storm Irene. Both events exceeded the 100-year flood at Rivervale.

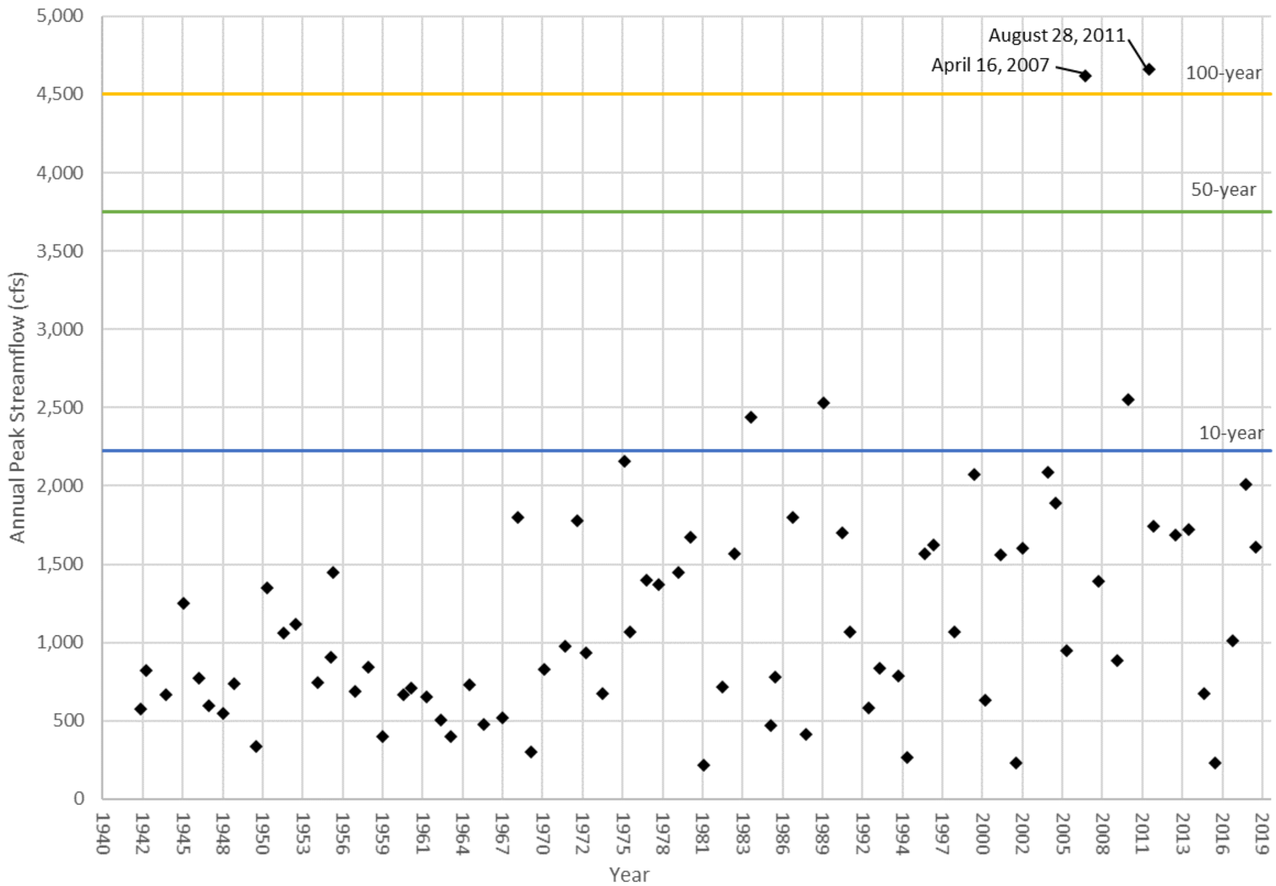


Figure 3-1: Hydrograph of Annual Peak Flow on the nearby Hackensack River at Rivervale, New Jersey 1942 – 2018

Annual peak flow on the nearby Mahwah River, recorded at Suffern since 1959, also provides a useful view of local flood magnitude. Figure 3-2 is a hydrograph showing annual peak flows with flood recurrence information superimposed. The August 2011 Tropical Storm Irene exceeded the 100-year flood at Suffern. Based on these two records of peak flows from nearby watercourses, it can be estimated that peak flows on Minisceongo Creek were near the 100-year flood event.

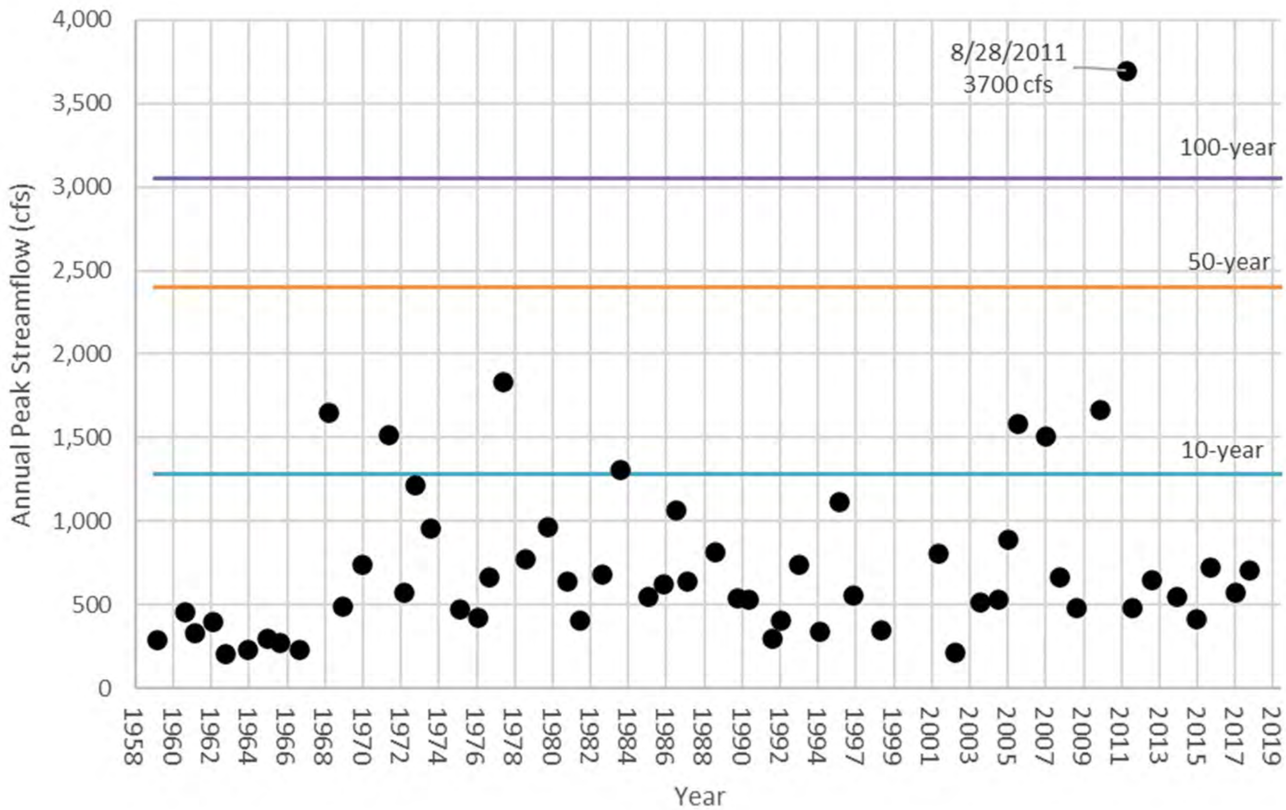


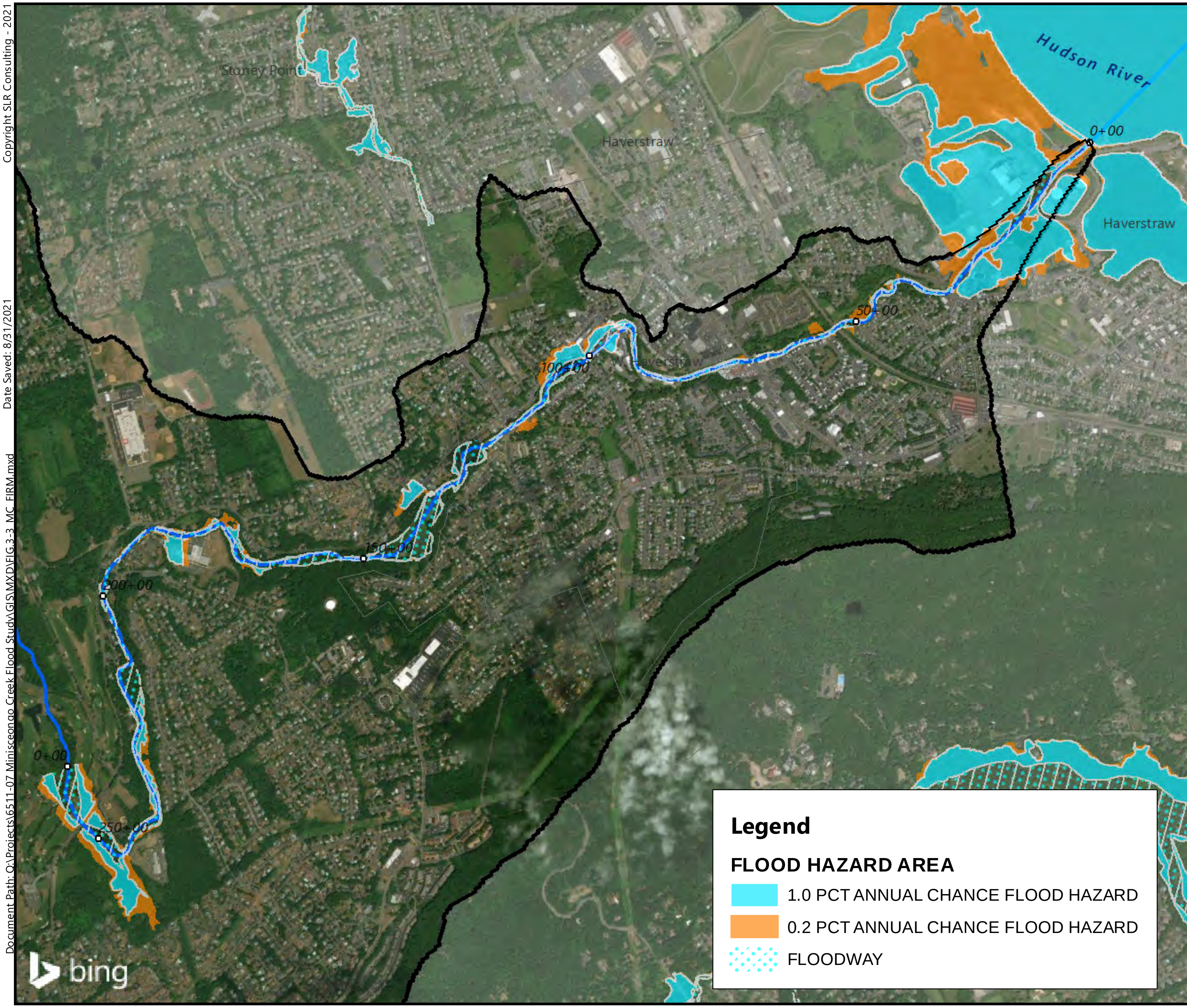
Figure 3-2: Hydrograph of Annual Peak Flow on the nearby Mahwah River at Suffern, New York 1959 – 2018

3.2 FEMA MAPPING

As part of the NFIP, FEMA produces FIRMs that demarcate the regulatory floodplain boundaries. As part of a FIS, the extents of the 100-year and 500-year floods are computed or estimated, as well as the regulatory floodway, if one is established. The area inundated during the 100-year flood event is also known as the SFHA. In addition to establishing flood insurance rates for the NFIP, the SFHA and other regulatory flood zones are used to enforce local flood damage prevention codes related to development in floodplains.

> Over the period of a standard 30-year 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 FIS for Rockland County (36087CV001A) has been effective since March 2014. Effective FIRM panels for Minisceongo Creek from the confluence with its South Branch to the Hudson River, and the South Branch from the main stem to the Haverstraw/Ramapo corporate limits were produced based on hydraulic modeling completed in 2011 under Contract No. DOS1427 for NYSOGS. The flood hazard areas delineated by FEMA are mapped in Figures 3-3 and 3-4. Residents are encouraged to consult the most recent products available from the FEMA Flood Map Service Center (https://msc.fema.gov/portal/home) for a more complete understanding of the flood hazards that currently exist.



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Document Path: Q:\Projects\6511-07 Minisceongo Creek Flood Study\GIS\MXD\FIG 3-3 MC FIRM.mxd

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231 MAIN STREET
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NEW PALTZ, NY 12561
845.633.8153

MINISCEONGO CREEK
FEMA FLOOD INSURANCE RATE MAP
SD112
ROCKLAND COUNTY
NEW YORK

SCALE 1 " = 2,000 '
DATE 8/31/2021
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FIG. 3-3

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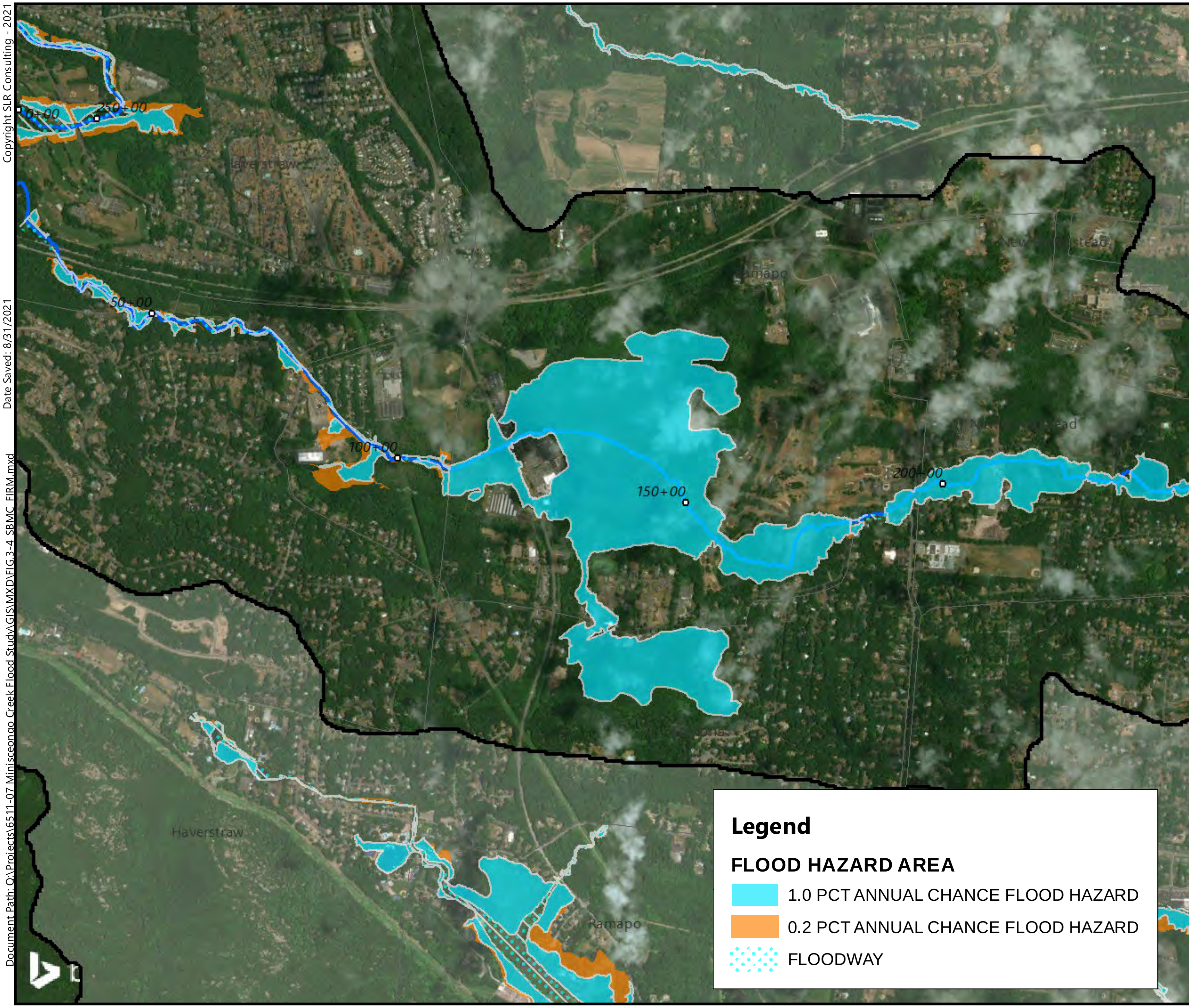

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SOUTH BRANCH MINISCEONGO CREEK
FEMA FLOOD INSURANCE RATE MAP
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ROCKLAND COUNTY
NEW YORK

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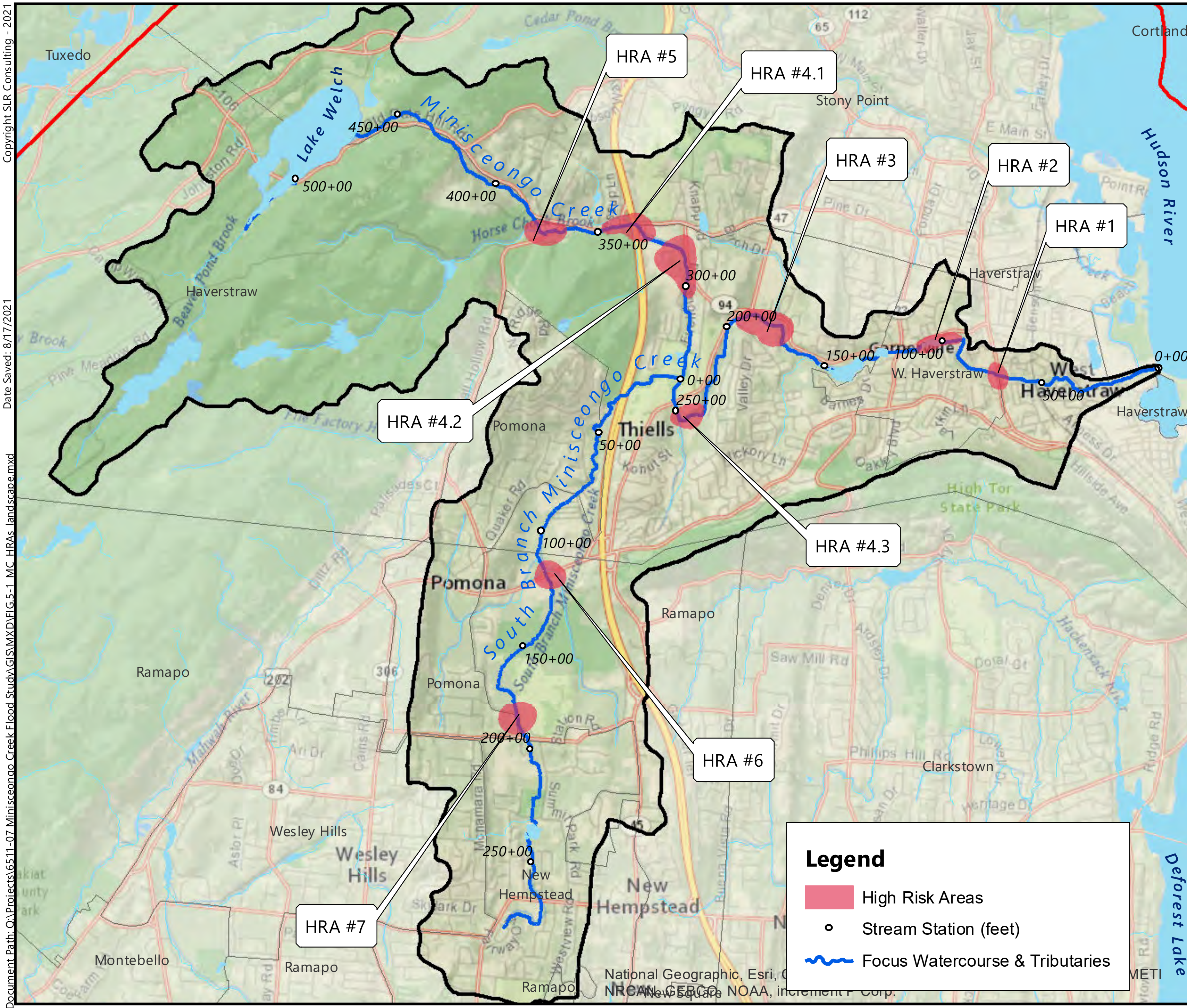
FIG. 3-4

4. FLOOD MITIGATION ANALYSIS

In this section, flood-prone areas within the Minisceongo Watershed are identified, and an analysis of flood mitigation considerations within each HRA is undertaken. HRAs were identified based on comments received during stakeholder meetings; conversations with municipal officials, emergency responders, landowners, and business owners; and through review of FEMA Flood Insurance Studies and Flood Insurance Rate Maps, County Hazard Mitigation Plans, and other documents. Factors with the potential to influence more than one HRA are also evaluated and discussed. Figure 4-1 shows the locations of all HRAs within the Minisceongo Creek watershed.



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MINISCEONGO CREEK HIGH RISK AREAS
MINISCEONGO CREEK FLOOD & RESILIENCY STUDY
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FIG. 4-1

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4.1 HIGH RISK AREA #1

HRA #1 is located in the village of West Haverstraw at the crossing of Route 9W over Minisceongo Creek and extends several hundred feet upstream (Figure 4-3). The crossing, pictured in Figure 4-2, is owned by the New York State Department of Transportation (NYSDOT) and was reportedly built in 1955. During Tropical Storm Irene, it was reported that severe erosion upstream of this culvert exposed electrical conduits and high-pressure natural gas transmission lines that cross under Minisceongo Creek, leaving them suspended and unsupported above the creek. The structure's North Atlantic Aquatic Connectivity Collaborative (NAACC) crossing code is *xy4120420473984086*, evaluated as being a *minor barrier* to fish passage, and it received a NAACC aquatic passability score of 0.69 out of 1.0.

Figure 4-2: View Looking Downstream at Route 9W Culvert Crossing of Minisceongo Creek

The twin-barreled, four-sided box culvert that carries Route 9W across Minisceongo Creek at approximately STA 67+00 (National Bridge Inventory [NBI] Bridge Identification Number [BIN]: 1007130) was incorporated into the SMS/SRH-2D model developed for this study. The two approximately 10-foot by 10-foot culvert barrels were modeled as adjacent conduits with pressure boundary conditions. Normal two-dimensional open-channel flow is simulated through the culvert unless the upstream water surface exceeds the ceiling elevation, in which case pressurized flow is computed within the structures. This occurs in the modeled 500-year flood and predicted future 100-year flood scenarios.

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MINISCEONGO CREEK HIGH RISK AREA #1

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PROJ. NO. 16511.00007

FIG. 4-3

Existing conditions modeling indicates that the culvert does have sufficient hydraulic capacity to convey flood flows without overtopping Route 9W under clear water conditions. However, this is a steep, highly entrenched and confined reach of Minisceongo Creek, and the further lateral constriction presented by the culvert creates the potential for debris jamming and generates adverse scour conditions downstream of the structure. Flood flow velocities of over 25 feet per second (fps) were modeled at the culvert outlet. The two barrels combine for a 20-foot effective channel width; the upstream channel is approximately 35 feet wide. Nearly vertical gabion basket revetment walls up to 20 feet tall confine the available floodplain to about 80 feet across. Flow contracts and accelerates through the structure, which acts as a smooth concrete nozzle, and the excess energy that develops is expended on the bed and banks of the channel as flow expands downstream. The presence of heavy stone armoring and steel sheet piling along the downstream banks suggests that this structure has experienced scour issues in the past.

Simulated replacement of these culverts with an 80-foot clear span bridge reduces upstream water surface elevations by about 4 feet in the 100- and 50-year floods and by 6 feet or more in the 500-year flood and projected future 100-year (Figure 4-4). Velocities through and downstream of the structure are reduced by up to about 6 fps. When this culvert is due for replacement, design of a bridge that at a minimum spans the existing floodplain is recommended.

It has been reported that the reach upstream of the Route 9W culvert is prone to erosion and bank failure; exposure of the gas transmission lines in Tropical Storm Irene occurred about a quarter of a mile upstream of the culvert. Creation of additional floodplain on the left bank was simulated to assess the effects of dispersing the creek's energy across a broader area. Up to 50 additional feet of floodplain width was added to approximately 2,700 linear feet of channel. The modeled floodplain benching begins approximately 500 feet downstream of the Garnerville Arts and Industrial Center and ends roughly 600 feet downstream of the 9W crossing. This area is generally undeveloped except for a shopping center parking lot along approximately 800 feet of the bank just upstream of the culverts. The modeled replacement 9W bridge span was increased from 80 feet to 130 feet to accommodate the additional floodplain in this scenario.

Modeling indicates that these floodplain connectivity enhancements may reduce flood flow velocities by between 1 and 2 fps in the 100-year flood along most of the affected reach, including at the utility crossings at STA 80+00. At the 9W crossing, modeled velocity reductions were by as much as about 8 fps. Water surface elevations are reduced by between approximately 0.2 feet and 0.5 feet compared to replacement of the culvert alone. This floodplain reclamation would be most effective when paired with the 130-foot bridge required to span it, which would be recommended.

The proposed floodplain bench was sized to flow roughly 1 foot deep in the 10-year flood. Reclamation of this approximately 3.1-acre area for such a floodplain would require reduction of the overbank elevation by up to about 15 feet and export of roughly 75,000 cubic yards of material. A conceptual layout of the proposed 9W replacement bridge and floodplain bench is depicted in Figure 4-5.

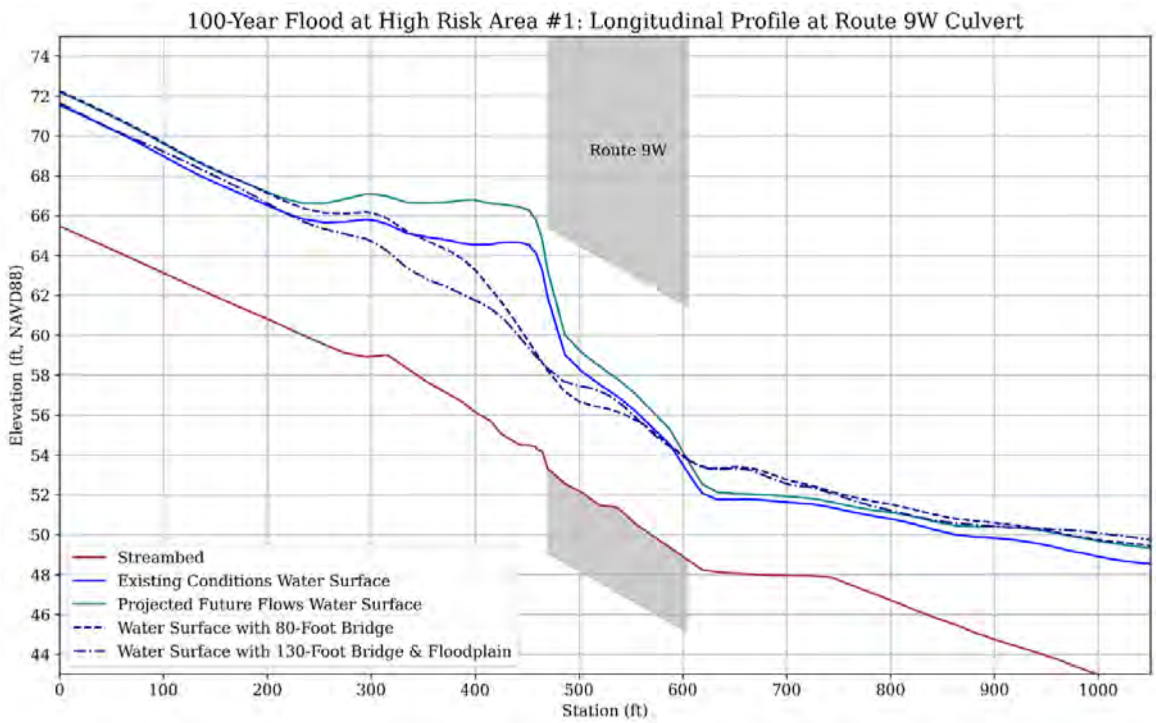
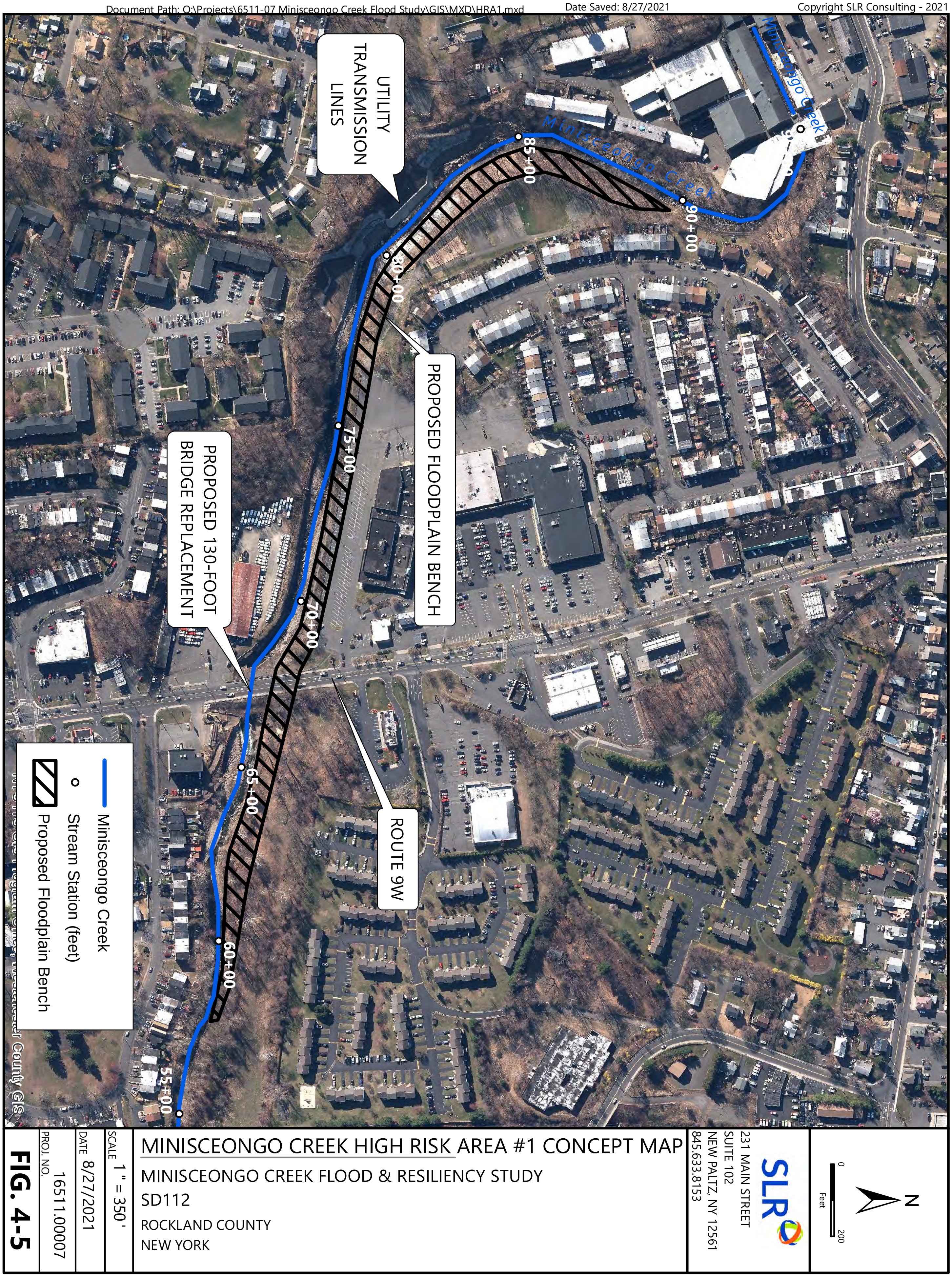


Figure 4-4: 100-Year Flood Water Surface Profiles through 9W Box Culvert under Existing, Projected Future, and Proposed Conditions Flood Scenarios


UTILITY TRANSMISSION LINES
PROPOSED FLOODPLAIN BENCH
PROPOSED 130-FOOT BRIDGE REPLACEMENT
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90+00
Minisceongo Creek
Stream Station (feet)
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231 MAIN STREET
SUITE 102
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845.633.8153
MINISCEONGO CREEK HIGH RISK AREA #1 CONCEPT MAP
MINISCEONGO CREEK FLOOD & RESILIENCY STUDY
SD112
ROCKLAND COUNTY
NEW YORK
SCALE 1" = 350'
DATE 8/27/2021
PROJ. NO. 16511.00007
FIG. 4-5

4.2 HIGH RISK AREA #2

HRA 2 is located in the hamlet of Garnerville, which is in the village of West Haverstraw between STA 93+00 and STA 135+00 (Figure 4-7). Three dams impound Minisceongo Creek upstream of the GAIC; listed from upstream to downstream they are Garnerville Dam, pictured in Figure 4-6, at STA 135+00 (NYS ID: 196-0337B), Suffern Lane dam (Rockland Print Co. Dam #2) at STA 122+00 (NYS ID: 214-0337A), and Bridge Street dam (Rockland Print Co. Dam) at STA 100+50 (NYS ID: 214-0336). These dams were associated with water supply, industrial, and recreational uses at different periods of their histories. The upstreammost dam, the Garnerville Dam, was recently modified to improve spillway performance and lower the NYSDEC's dam hazard classification from Class C – High Hazard to Class B – Intermediate Hazard. The dam spillway crest was lowered by 6.5 feet in 2007 and was reclassified by NYSDEC following a hazard classification review in 2018 by Bergmann Engineers. Further reduction to a Class A – Low Hazard dam is not currently possible because it has been concluded that failure of the Garnerville Dam is likely to result in cascading failure of the Suffern Lane dam, which is a Class B hazard dam.

Figure 4-6: View of the Bridge Street dam from downstream. The Bridge Street bridge is visible just upstream.

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NEW PALTZ, NY 12561
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MINISCEONGO CREEK HIGH RISK AREA #2
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FIG. 4-7

According to NYSDEC Division of Water (DOW) Draft Technical and Operational Guidance Series (TOGS) 3.1.5, Section III. D. 8., "if [based on dam breach and structural analyses,] a dam failure contributes to the failure of one or more downstream dam(s), then the hazard class of the upstream dam should be at least as high as the classification of the downstream dam(s) and should reflect the likelihood of the threat of interruptions and damage attributable to incremental domino-like cascade failure(s) of the downstream dam(s)." Therefore, the Garnerville Dam cannot be classified as less hazardous than the Suffern Lane dam, which is just 0.2 miles downstream and is reportedly in a state of disrepair (Bergmann Engineers 2020). Partial or complete removal of the Suffern Lane dam has been proposed and conceptually designed by Bergmann Engineers in order to reduce or eliminate the hazard posed by the dam and facilitate potential further reductions to the Garnerville Dam's hazard classification (Bergmann Engineers 2020). The condition of the Suffern Lane dam has been rated by NYSDEC Dam Safety as "Unsound, More Analysis Needed."

The Bridge Street dam was reclassified as a Class A – Low Hazard dam in 2007. Removal or modification of this dam is unlikely as it contributes significantly to the character and aesthetic of the GAIC.

Between the Suffern Lane dam and the Bridge Street dam impoundment, Minisceongo Creek flows through an especially confined reach between Church Street on the right (south) bank and West Railroad Avenue on the left (north). The stream reportedly underwent lateral planform adjustment during Tropical Storm Irene, which brought the primary channel roughly 50 feet closer to the Church Street neighborhood than it had been. This has induced failure and mass wasting of the stream's high right bank at STA 109+00.

Two structures span the creek as it flows between the historical mill buildings that compose both banks from STA 93+60 to STA 100+50 (Figure 4-8). Extensive flooding and debris jamming during Tropical Storm Irene in 2011 (Figure 4-9) resulted in partial collapse of one of the walls that define the stream banks.

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MINISCEONGO CREEK HIGH RISK AREA #2

MINISCEONGO CREEK FLOOD & RESILIENCY STUDY

SD112

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NEW YORK

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DATE 4/8/2022

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FIG. 4-8

Figure 4-9: Garnerville Arts & Industrial Center during Tropical Storm Irene in 2011. View looking upstream from Building #5. Photo courtesy of Garnerville Arts & Industrial Center.

The Bridge Street bridge (NBI BIN: 3345870) at STA 100+80, Garnerville Dam, Suffern Lane dam, Bridge Street dam, and two structures spanning Minisceongo Creek were incorporated into the SMS/SRH-2D hydraulic model developed for this study. Bridge Street bridge's NAACC crossing code is *xy4120779373991879,* evaluated as being an *insignificant barrier* to fish passage with a NAACC aquatic passability score of 0.95 out of 1.0.

Modeling demonstrates that in the vicinity of the GAIC there is complex hydraulic interdependence between the bridge, the dam, and the two building crossings in the context of a laterally confined, vertically walled channel. The upstream structure spanning the creek, the western section of Building 26A, shown in Figure 4-10, is undersized for flood flows, and the building's piers exacerbate flooding by obstructing flow in clear water flood conditions. These piers are also prone to snagging debris, which may increase upstream flood inundation extents as well as the proportion of flows that flank the GAIC to the north. The existing floor slab of Building 26A is modeled as overtopping by as much as 9 feet in the 100-year flood. This reportedly occurred in Tropical Storm Irene, during which extensive debris jams developed against the piers beneath the structure as well.

Figure 4-10: View looking downstream at upstream face of Building 26A at the GAIC just downstream of the Bridge Street dam. The elevated building 33A is also visible. Piers and other obstructions restrict flow and are prone to debris jamming.

To better understand how the structure impacts flood flows, removal of the building and its substructural components was simulated in the two-dimensional model. Results show that the structure crossing has a dramatic influence on the hydraulics of the dam immediately upstream during floods. The building is situated only approximately 50 feet downstream of the spillway crest and appears to interfere with the hydraulic jump that would otherwise develop downstream of the dam during a flood. This creates a backwater that reaches about a quarter of a mile upstream of the dam; modeling indicates that the 100-year flood water surface elevation in the impoundment can be reduced by approximately 2.1 feet by removing the building and piers, which would prevent the pond from overflowing and flanking the GAIC to the left (north). This also decreases the potential for debris jamming at the Bridge Street bridge by increasing its freeboard.

Removal of only the western portion of the Building #26A floor, which is the upstreammost structure spanning Minisceongo Creek at the GAIC, was simulated as well. This structure includes the 6± foot tall parapet wall at its upstream face and arrays of piers in the channel below. The remaining 190± linear feet of Building 26A is a channel-spanning structure, is not supported on intermediate piers, and has a reduced hydraulic profile without the solid concrete parapet. Removable guide rails are currently in place for the Main Road and Cross Creek bridge crossings on the GAIC site, which may be removed in the event of a flood forecast to reduce the potential for debris snagging. Without these obstructions to flow and with reduced interference with the dam's hydraulics, 100-year water surface elevation reduction of up to 2.0 feet was modeled upstream. This is shown on the flood profiles in Figure 4-11. The remaining parts of this structure would continue to overtop by about 2.5 feet in the 100-year flood, but upstream reductions in flooding are only very slightly less than if the entire building were removed. Some interference with the Bridge Street dam spillway hydraulics would remain but would be a significant improvement over the existing conditions. By eliminating the building's piers, this alternative is also expected to reduce chronic debris jamming at the GAIC that has been reported in more frequent, less severe flood events than those modeled.

Modeling indicates that the downstream structure (Building #5B) crossing can pass the 100-year flood with roughly 1 foot of freeboard under clear water conditions but remains susceptible to debris jamming. Significant backwaters develop upstream as the conduit is pressurized at its inlet in the modeled 500-year food and projected future 100-year flood discharge.

Two-dimensional hydraulic modeling indicates that the Suffern Lane dam is flanked on its right closure embankment in less than the 50-year flood. As a Class B, Intermediate Hazard dam, NYSDEC Dam Safety regulations stipulate that the Spillway Design Flood (SDF) is 150 percent of the 100-year flood discharge, meaning that the structure's spillway must have the capacity to convey this flow without the dam overtopping. Modeling indicates that the dam does not meet this requirement, as it is shown to overtop in significantly lesser discharges.

As a Class A, Low Hazard dam, the Bridge Street dam's SDF is equal to the 100-year flood discharge, which it currently cannot convey. However, modeling shows that removal of the western portion of the floor of Building 26A will alleviate overtopping and flanking of the dam to the north, allowing the spillway to pass its required flow.

Garnerville Dam is a Class B dam, and modeling indicates that the top of dam would overflow in the SDF of 150 percent of the 100-year flood but that the structure could pass the Class A, 100-year flood SDF if its hazard were so classified, as is proposed following removal or modification of the Suffern Lane dam.

Under flood conditions, the backwater caused by the GAIC buildings and Bridge Street dam extends approximately to a reach along Church Street that is currently experiencing mass failure of its right bank. Flow velocities decrease significantly as the stream meets the impounded backwater here, and the negative energy gradient results in sediment deposition at this location. This quasideltaic environment is dynamic and prone to braiding or anabranching, as well as both chronic and acute episodes of lateral and vertical adjustment. This is presumably the mechanism by which recent planform adjustment and bank erosion were initiated and must be accommodated and accounted for in restoration design. Note that the upstream extent of backwater flooding could shift as far as 400 feet downstream if recommended flood mitigation measures are implemented at the GAIC, which would shift the zone of deposition roughly the same distance.

Floodplain benching along 250 feet of the left bank upstream of the right bank erosion site was modeled to assess whether the creek's energy may be diffused before encountering this bank and whether this may have significant flood hazard mitigation benefits. The affected area contains Viohl Park, which would be proposed to be relocated to this new floodplain, between 4 feet and 6 feet lower in elevation but otherwise essentially unchanged and with only a nominal loss of area. This floodplain enhancement was modeled alone and in combination with removal of the western portion of the floor of Building 26A at the GAIC and is depicted as a conceptual layout in Figure 4-12. Results indicate that the floodplain bench would be effective at reducing 100-year flood velocities along the actively eroding bank by 25 percent and shear stresses by 28 percent. This does not address the backwater deposition issue but would reduce hydraulic erosion along the toe of the bank under clear water conditions due to the substantial decrease in erosive energy. However, when this floodplain is modeled in combination with removal of the western portion of the floor at Building 26A and its piers, not only are incoming velocities and shear stresses reduced, but the zone of deposition is shifted downstream, decreasing the likelihood of further aggradation-induced lateral migration at the current bank failure site.

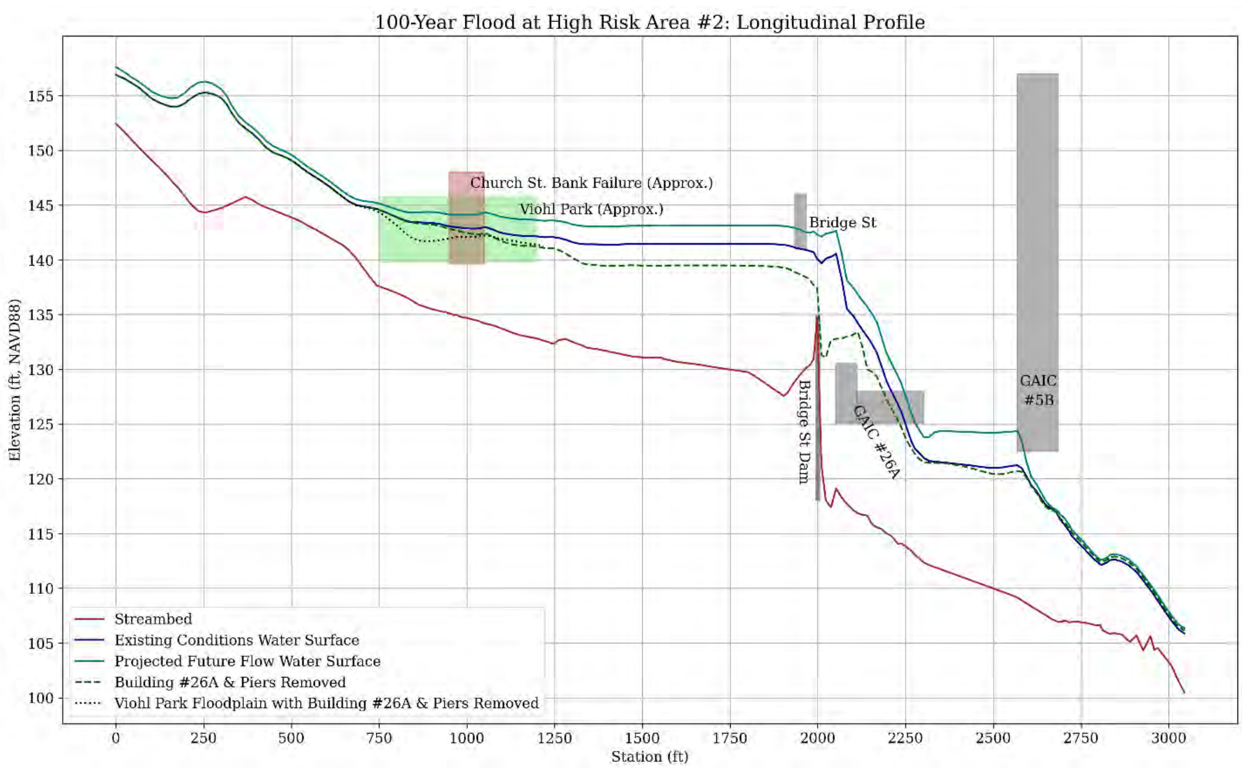

Figure 4-11: 100-Year Flood profiles at HRA #2 showing existing conditions, removal of the western portion of the floor at Building 26A and its piers at the GAIC, and floodplain benching upstream at Viohl Park

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MINISCEONGO CREEK HIGH RISK AREA #2 CONCEPT MAP

MINISCEONGO CREEK FLOOD & RESILIENCY STUDY

SD112

ROCKLAND COUNTY

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SCALE 1 " = 250 '

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FIG. 4-12

4.3 HIGH RISK AREA #3

HRA 3 is located in Thiells, a hamlet in the town of Haverstraw (Figure 4-14). Thiells Elementary School is situated along Minisceongo Creek (pictured in Figure 4-13) at STA 180+00 and is mapped as being partially within the SFHA delineated by FEMA. The Director of Facilities for the North Rockland School District has reported that the school building experienced severe flood damage during Tropical Storm Irene in August 2011, with flooding along the north side of the school building, which is closest to the creek. Water entered the building through the HVAC system and flooded approximately two-thirds of the first floor. Extensive repairs were required, including replacement of sheetrock and renovation of the library. During Superstorm Sandy in 2012, water flooded the school parking lot but did not damage the building.

The reach of Minisceongo Creek that flows alongside Thiells Elementary School was included in the two-dimensional SMS/SRH-2D hydraulic model developed for this study. The school is located on a broad section of floodplain while the creek is much more confined both upstream and downstream. Existing conditions modeling indicates that flooding of the school results from water that leaves the channel just upstream; the building is elevated on fill downstream to the east but is very nearly at the same elevation as the adjacent floodplain on its upstream side to the northwest.

To assess whether flooding of the Thiells School can be alleviated by containing floodwaters within a narrower but more accessible floodplain, a 60-foot-wide bench along approximately 550 linear feet of Minisceongo Creek's right (south) bank was modeled where the creek flows along the north side of the school. This alternative requires reclamation of several parking spaces and relocation or reconfiguration of a playground structure. This provides supplemental flood flow conveyance at a lower elevation than the school buildings at the critical location where water leaves the primary channel. A conceptual layout of the floodplain bench is depicted on Figure 4-15.

The terrain surface elevation within this simulated floodplain was reduced by between about 1 foot to about 6 feet within this roughly 1-acre area, representing about 5,500 cubic yards of material. The shallowest cutting is at the floodplain's upstream extent, and the depth grows downstream as the bench follows the river's slope, ultimately tying in to the elevation of the sports fields just east of the school. This results in up to a 1.1-foot decrease in flood water surface elevations in the modeled 100-year event and a 1.6-foot reduction in the 500-year flood. In the modeled future 100-year flood scenario, water surface elevation (WSEl) was reduced by 1.4 feet. With these reductions, the building is not expected to experience flooding in either the current or projected future 100-year flows, and flood depths would be limited to less than 0.2 feet along the northern side of the school building during the 500-year discharge. A drop in in-channel velocity of 2 to 3 fps is also observed where this floodplain bench was simulated.

Figure 4-13: Thiells Elementary School Viewed from Suffern Lane

MINISCEONGO CREEK HIGH RISK AREA #3

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FIG. 4-14

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MINISCEONGO CREEK HIGH RISK AREA #3 CONCEPT MAP

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FIG. 4-15

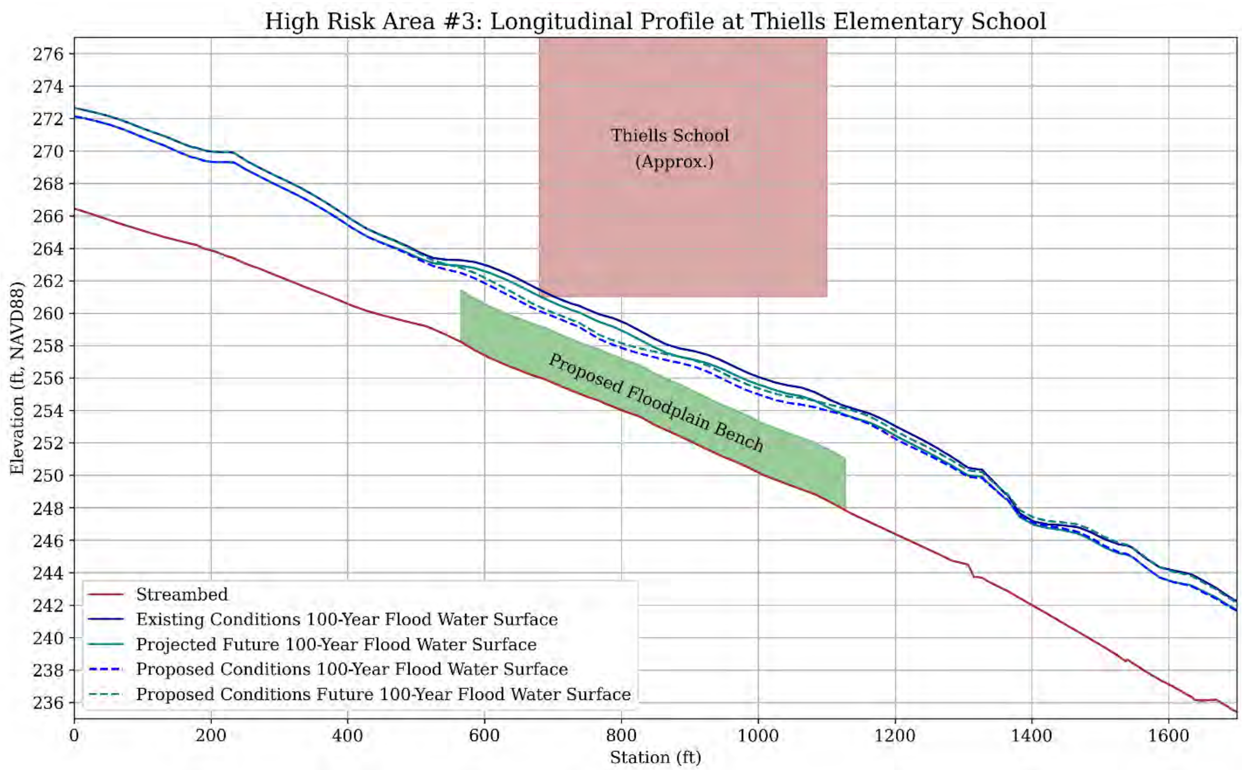

Figure 4-16: Water surface profiles near the Thiells Elementary School in HRA #3. Current and projected future 100-year floods are shown under existing conditions and with the proposed floodplain benching.

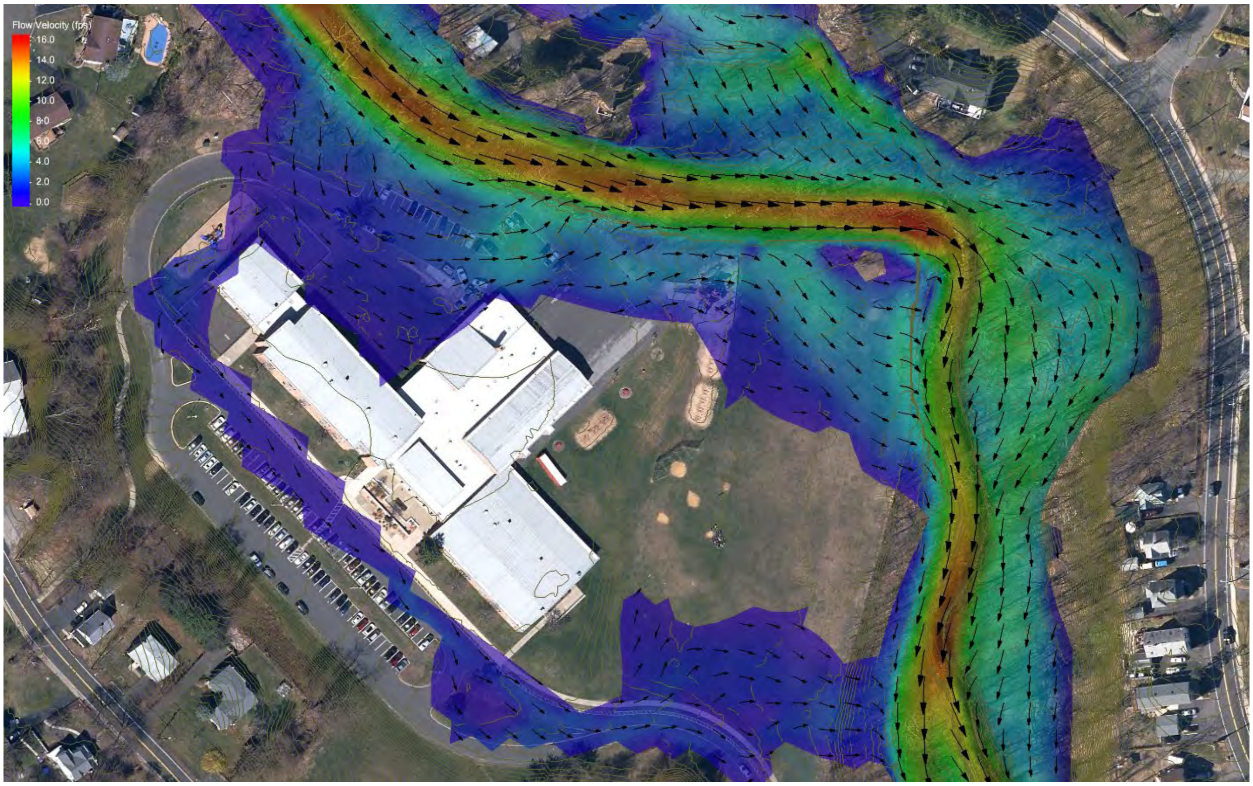

Figure 4-17: Velocity distribution and flow paths in the modeled 500-year flood under existing conditions. The school is flooded by water that spills over the stream banks just upstream.

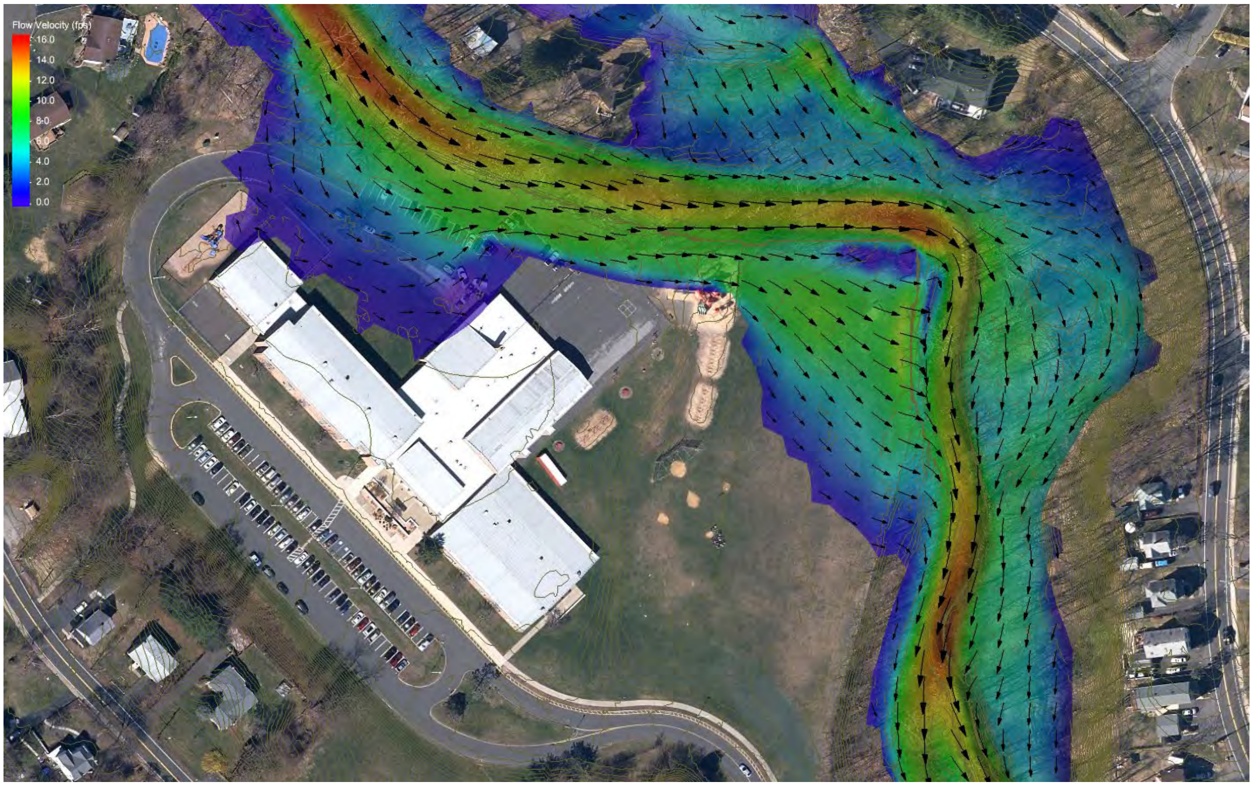

Figure 4-18: Velocity distribution and flow paths in the modeled 500-year flood under proposed conditions with floodplain benching along the right overbank. This floodplain is modeled as containing the current and future 100-year floods without affecting the school. The building may still be affected by the 500-year discharge although flood depths along the north side of the school have been reduced to less than 0.2 feet. Also note reduced in-channel velocities compared to Figure 4-17.

4.4 HIGH RISK AREA #4

HRA 4 is located in Haverstraw, beginning upstream at Willow Grove Road near the Exit 14 on/off ramp of the PIP at STA 330+00 and extending downstream to the Haverstraw Department of Public Works (DPW)/Highway Garage facility access road, mapped as "4WD Road" at STA 245+00. The limits of HRA 4 are shown on Figure 4-19. Four crossings of Minisceongo Creek in this HRA were assessed for potential flood mitigation benefits and are described further in the subsections below: the PIP Exit 14 northbound ramp, a single-span arch bridge at STA 330+00 (NBI BIN: 1068950); Storrs Road, a single-span steel girder bridge at STA 306+00 (NBI BIN: 5521530); a deteriorating three-span concrete bridge that provides access to the defunct Rockland Print Co. power generation facility at STA 293+00 (NBI unlisted); and the twin-barreled four-sided box culvert that leads to the DPW facility at STA 245+00 (NBI unlisted). Both the PIP ramp and Storrs Road experience overtopping flows when their bridges are flanked by floodwaters; the culverts at the DPW garage were reportedly damaged in Tropical Storm Irene.

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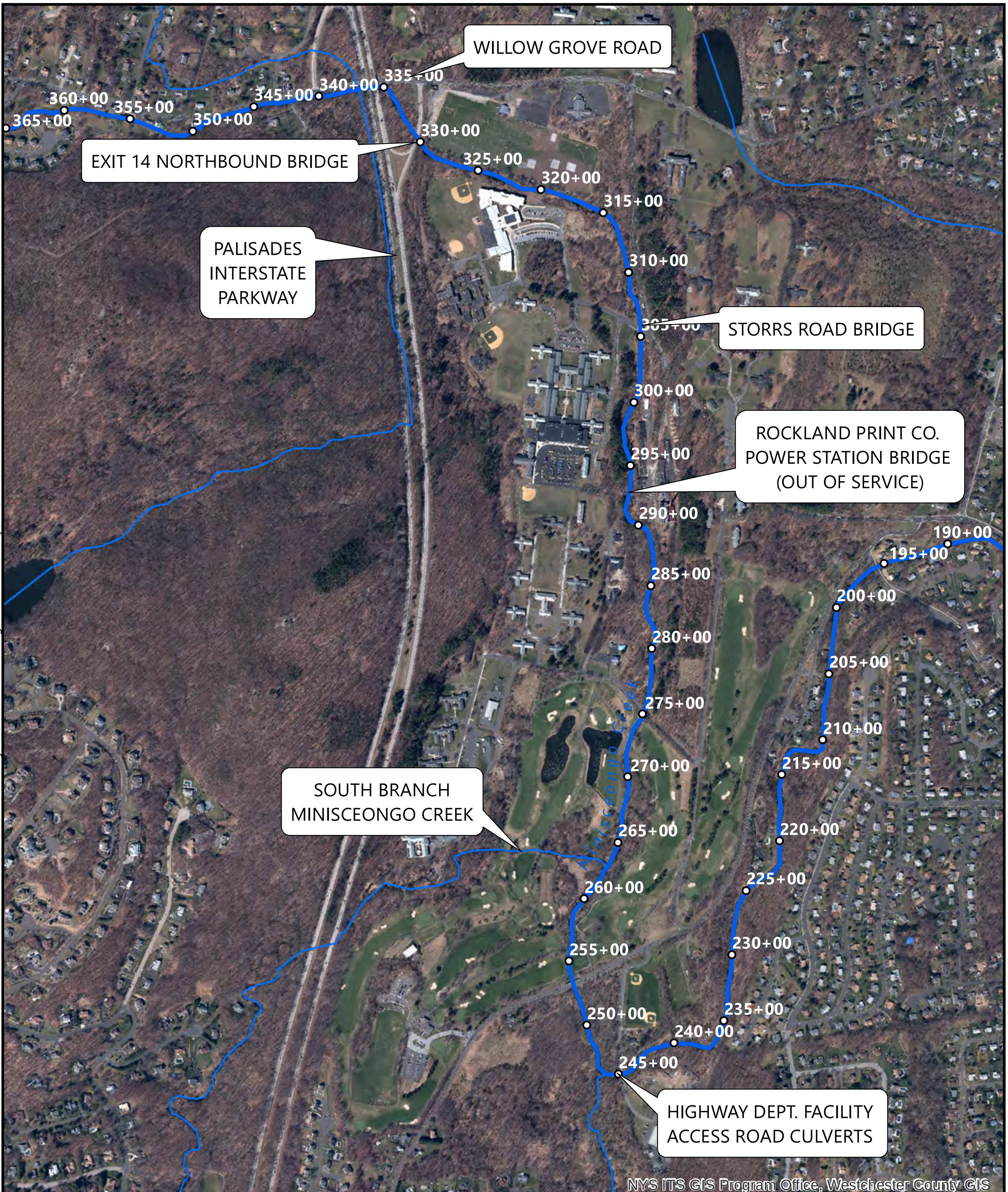

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MINISCEONGO CREEK HIGH RISK AREA #4

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FIG. 4-19

Hydraulic modeling of HRA #4 was conducted using the two-dimensional SMS/SRH-2D model that was developed for this study.

4.4.1 PALISADES INTERSTATE PARKWAY EXIT 14 NORTHBOUND AND WILLOW GROVE ROAD

After flowing through the constriction of the PIP crossing, which spans both the watercourse and CR 98/Willow Grove Road, Minisceongo Creek makes a fairly sharp bend to the south and expands onto what is a relatively accessible and connected floodplain downstream. Overbank flooding on the left (north) side of the creek reportedly inundates sections of Willow Grove Road and overtops the Exit 14 on/off ramp for northbound traffic on the PIP. This low-lying roadway is skewed with respect to the creek's alignment, and its bridge crossing of the creek appears to be a significant hydraulic constriction. The PIP crossing has the NAACC crossing code *xy4121999374033548* and was evaluated as being an *insignificant barrier* to fish passage with a NAACC aquatic passability score of 0.95 out of 1.0. Similarly, the Exit 14 on/off ramp bridge has the NAACC crossing code *xy4121904474032523* and was evaluated as being an *insignificant barrier* to fish passage with a NAACC aquatic passability score of 0.91 out of 1.0.

The backwater that develops upstream of the northbound on/off ramp bridge, shown in Figure 4-20, exacerbates on ramp overtopping, which is concentrated at the low point in the road about 350 feet north of the bridge. After overtopping the on ramp, floodwaters flow across the sports fields on the left overbank downstream. Modeling indicates that water flows across about 140 feet of the roadway up to about 6 inches deep in the 10-year flood event; in the modeled 100-year flood, water flows across the road up to a foot deep at as fast as 6 fps over about 230 feet of the road. Under projected future climate conditions, the modeled 100-year flood flows across the road up to 1.2 feet deep at nearly 7 fps. Willow Grove Road is also modeled as flooding in flows greater than the 10-year magnitude at its lower elevations where it shares a bridge with Minisceongo Creek to pass underneath the PIP.

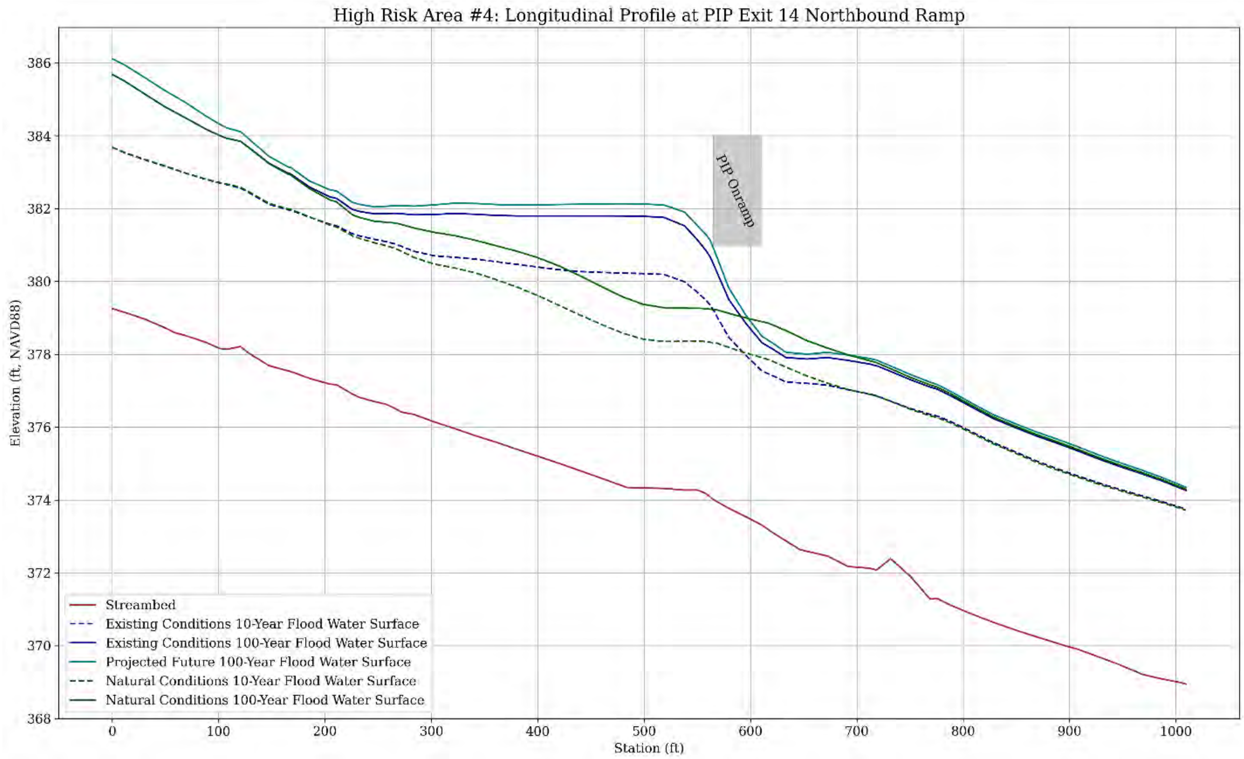

Figure 4-20: Longitudinal profiles of Minisceongo Creek at the Palisades Parkway Exit 14 northbound on ramp. The backwaters generated by the undersized brige slightly increase flooding of the approach roadway.

To assess alternatives, the 2D model geometry was modified to reflect elimination of the constriction associated with the bridge and roadway. Removal of the structure as well as the elevated approach roadway embankments on both riverbanks was simulated. Results show that while the constriction exacerbates the severity of the upstream flooding, substantial floodplain activation still occurs along this reach without the bridge's backwater. An increased bridge span alone would therefore not alleviate flooding of the on ramp, which occurs as a function of both the stream and roadway alignments in the context of the broader valley, as well as the road embankment elevation. Under this simulated "natural" condition, flooding of Willow Grove Road is only marginally reduced, as it occurs at very nearly the upstream limit of the backwater caused by the PIP exit ramp bridge.

Minisceongo Creek has significant floodplain access along this reach, which is lightly forested upstream of the Exit 14 northbound ramp; downstream, it is primarily characterized by a sports field complex on the left overbank and a school and fields on the right, with a small, forested riparian buffer along both banks. The valley slopes nearly perpendicularly to the on ramp, and the primary stream channel appears to have been placed in an unnatural, semistraight alignment that is highly skewed to the valley upstream and nearly parallel downstream. When floodwaters spill over the stream banks upstream of the bridge, floodplain flows follow the valley gradient, which brings it across the road and onto the sports fields, shown in Figure 4-21. Similar conditions are observed under the modeled natural conditions, shown in Figure 4-22, although less flow is confined to the channel in this scenario.

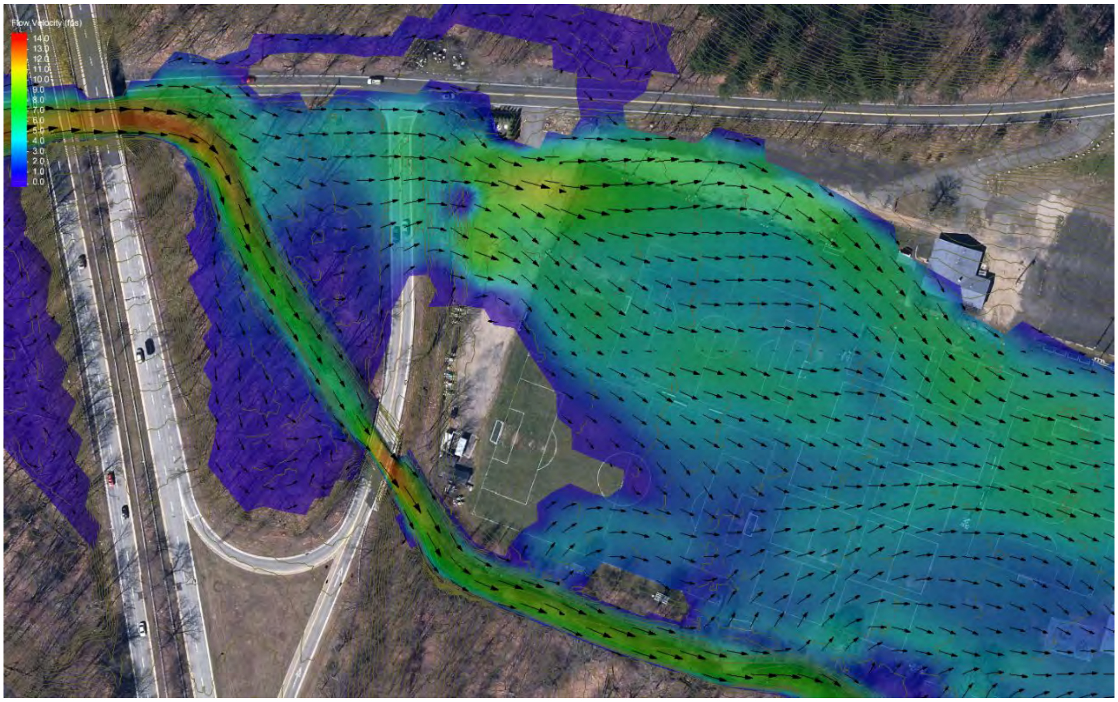

Figure 4-21: Velocity distribution and flow paths in the vicinity of the Exit 14 PIP on ramp in the modeled 100-year flood in existing conditions. When flows back up behind the undersized bridge, floodwaters that leave the channel upstream flow across the PIP on/off ramp.

One positive consequence of the current configuration is that the hydraulic stresses acting on the bridge associated with the flow contraction begin to be relieved when roadway overtopping initiates. As floodwaters rise further, an increasing component of the additional discharge flows across the floodplain rather than being forced through the undersized bridge, which can generate adverse scour conditions that may ultimately lead to failure. There can be benefits to overtopping relief in terms of economical long-term infrastructure resilience, as postflood roadway repairs are generally far less costly than bridge repairs or replacement, and it is often difficult or impractical to provide conveyance comparable to a full floodplain with relief culverts when low-lying roadway embankments are elevated. However, loss of service of the roadway due to flooding can present an immediate hazard to those in the vicinity and may interrupt critical links in flood response and life safety networks. Depending on factors such as roadway functional classification, traffic volumes, availability and length of detours, ability to deploy road closure signage, and proximity to emergency services facilities, roadway overtopping may or may not be acceptable.

Overtopping of the PIP on/off ramp may be alleviated through embankment elevation in combination with increased hydraulic capacity of the crossing. To avoid creating adverse scour conditions at the bridge, to the extent practical, any embankment elevation should be accompanied by provision of sufficient overbank relief capacity so as to not unduly cause a deviation from the natural balance of channel-to-overbank flow distribution under flood conditions. Table 4-1 presents the flood flow distributions through the bridge versus over the roadway under existing conditions and in-channel versus overbank in the modeled "natural" conditions with the bridge and approach roadway removed. The constriction of the existing bridge forces slightly more flow onto the overbanks than would naturally occur. Therefore, replacement of the bridge with a larger span would reduce the necessary floodplain relief capacity but only to a small degree.

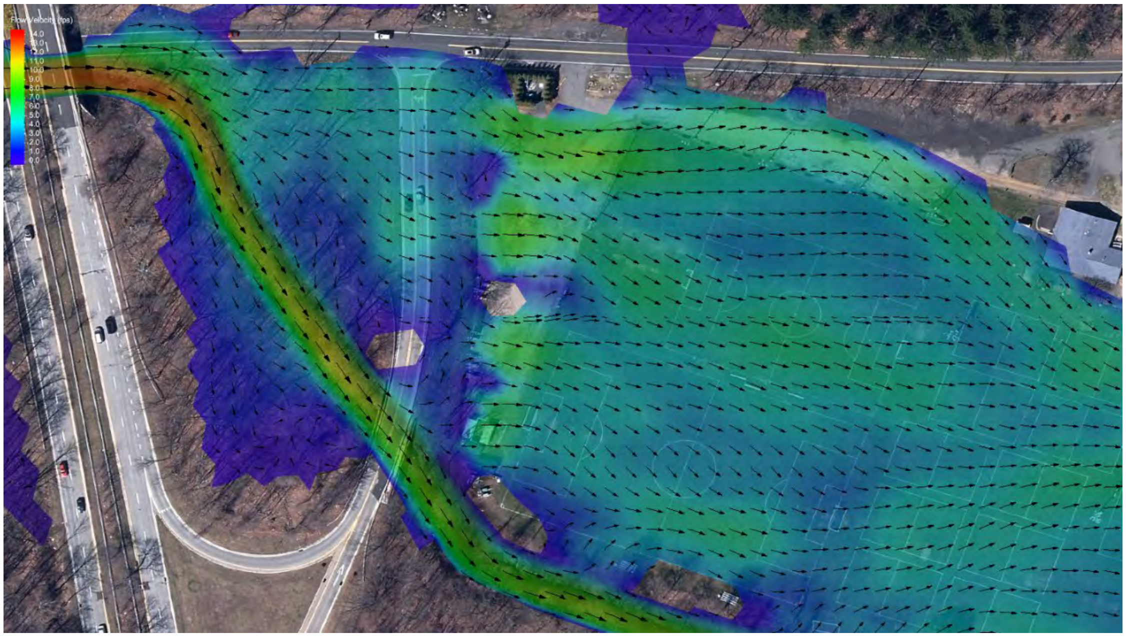

Figure 4-22: Velocity distribution and flow paths in the vicinity of the Exit 14 PIP on ramp in the modeled 100-year flood in "natural" conditions, with the bridge and approach embankment removed. The area experiences significant flooding even without the hydraulic constriction, thus roadway overtopping cannot be eliminated with a larger bridge span alone.

Table 4-1: Flood flow distribution at the PIP Exit 14 northbound crossing of Minisceongo Creek under existing and "natural" conditions. The undersized bridge forces additional flow over the roadway.

Flood Event	Existing Channel (bridge) Flow (cfs)	Existing Overbank (overtopping) Flow (cfs)	"Natural" Channel Flow (cfs)	"Natural" Overbank Flow (cfs)
10-Year	1,032	29	1,015	46
50-Year	1,340	410	1,379	371
100-Year	1,452	711	1,552	611
500-Year	1,656	1,624	1,855	1,425

cfs = cubic feet per second

4.4.2 STORRS ROAD – WILLOW GROVE ELEMENTARY SCHOOL AND FIELDSTONE MIDDLE SCHOOL

About half a mile downstream of the PIP on ramp, Storrs Road crosses Minisceongo Creek with an approximately 37-foot-span bridge. Its NAACC crossing code is *xy4121519174026470,* and it was evaluated as being *an insignificant barrier* to fish passage with a NAACC aquatic passability score of 0.93 out of 1.0. This road provides access to the Willow Grove Elementary School and the Fieldstone Middle School.

Similar to the PIP on/off ramp, Storrs Road is a low-lying roadway that traverses Minisceongo Creek's floodplain where it is particularly accessible. Water flows across the roadway as much as 3 feet deep in the modeled 100-year flood. As with the on-ramp crossing upstream, the hydraulic stresses acting on the bridge associated with the flow contraction begin to be relieved when roadway overtopping initiates. As floodwaters rise further, an increasing component of the additional discharge flows across the floodplain rather than being forced through the undersized bridge, which can generate adverse scour conditions that may ultimately lead to failure. There can be benefits to overtopping relief in terms of economical long-term infrastructure resilience as postflood roadway repairs are generally far less costly than bridge repairs or replacement, and it is often difficult or impractical to provide conveyance comparable to a full floodplain with relief culverts when low-lying roadway embankments are elevated. However, loss of service of the roadway due to flooding can present an immediate hazard to those in the vicinity and may interrupt critical links in flood response and life safety networks. Depending on factors such as roadway functional classification, traffic volumes, availability and length of detours, ability to deploy road closure signage, and proximity to emergency services facilities, roadway overtopping may or may not be acceptable.

Alleviating flooding of this roadway would require embankment elevation, a considerably larger bridge span, and likely at least one large relief structure. Table 4-2 presents the proportion of flows that pass through the span or in the channel versus overbank flow under existing versus "natural" conditions, with the bridge and approach roadway removed from the model. In this case, the imposition of the approach roadway embankment forces flows through the bridge rather than on the overbanks. This may generate an adverse scour condition under flood flows. Roadway overtopping may be alleviated by embankment elevation and provision of floodplain relief; however, there may be a more attractive alternative solution that drastically reduces the crossing's encroachment on the floodplain. An existing terrain constriction approximately 250 feet downstream of the current bridge appears to be a more suitable location for a stream crossing. Here, a 70-foot bridge can span the entire present and future 100-year floodplains as modeled. Figure 4-22B presents modeled 100-year flooding depths at this location.

Table 4-2: Flood Flow Distribution at the Storrs Road Crossing of Minisceongo Creek under Existing and "Natural" Conditions

Flood Event	Existing Channel (bridge) Flow (cfs)	Existing Overbank (overtopping) Flow (cfs)	"Natural" Channel Flow (cfs)	"Natural" Overbank Flow (cfs)
10-Year	1,061	0	1,056	5
50-Year	1,618	132	1,548	202
100-Year	1,764	399	1,655	508
500-Year	1,969	1,311	1,852	1,428

cfs = cubic feet per second

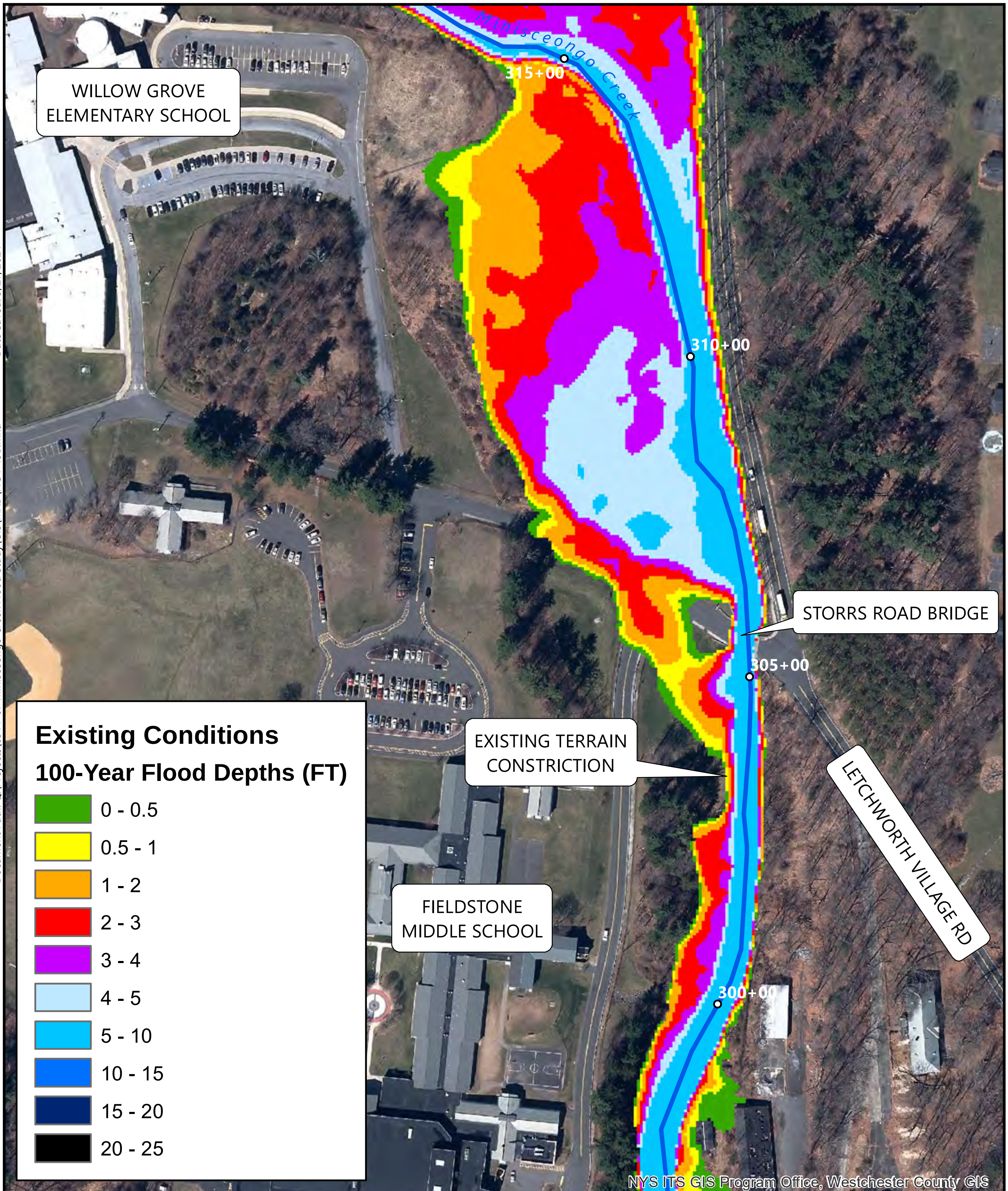

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FIG. 4-22B

4.4.3 ROCKLAND PRINT COMPANY POWER PLANT BRIDGE

About 1,300 feet downstream of the Storrs Road bridge, a derelict three-span, single-lane bridge crosses Minisceongo Creek, pictured in Figure 4-23. This structure once provided access to the power generation building complex for the Rockland Print Company, which itself has been abandoned and is in a state of disrepair. The bridge has an unusually thick superstructure and deck, which combine to be roughly 8 feet in height. The structure's NAACC crossing code is *xy4121177674026762,* and it was evaluated as being an *insignificant barrier* to fish passage with a NAACC aquatic passability score of 0.94 out of 1.0. Deep scour was observed in the channel bed underneath the span, which is modeled as pressurizing in the 50-year flood and greater. Because this structure is no longer necessary and is a safety hazard in its deteriorated condition, removal of the crossing was simulated to assess whether eliminating the hydraulic constriction would have any flood mitigation benefits upstream or in the adjacent areas. Minor reductions in upstream flood water surface elevations were observed, but simulated bridge removal did not significantly improve conditions at nearby infrastructure or buildings under clear water flood conditions. Nevertheless, the bridge is susceptible to debris jamming, and the structure itself would create a significant obstruction to flow in the event of failure.

Figure 4-23: Rockland Print Company Power Plant Bridge

4.4.4 WEST HAVERSTRAW DEPARTMENT OF PUBLIC WORKS ACCESS ROAD

Approximately one mile downstream of the old power plant, after flowing through a golf course, confluencing with its South Branch, and passing under Thiells Mount Ivy Road/CR-47, Minisceongo Creek meets an unnamed tributary coming in from the south just before beginning what amounts to a nearly 180-degree bend. Here, the West Haverstraw DPW facility is accessed via a twin-barreled, four-sided box culvert, pictured in Figure 4-24. The structure's NAACC crossing code is *xy4119982174027117,* and it was evaluated as being an *insignificant barrier* to fish passage with a NAACC aquatic passability score of 0.90 out of 1.0. Each opening measures 8± feet high by 14± feet wide. What appears to be a sanitary utility line crosses the creek immediately upstream of the culverts but is elevated above the modeled 500-year clear water flood water surface. Modeling indicates that the culverts can pass up to the 50-year flood under open-channel flow conditions. The culvert can pass the 100-year flood with about 1 foot of pressure head at the inlet and the future 100-year flood scenario with just over 2 feet of pressure head. The modeled 500-year flood overwhelms the structure and overtops the road. Flooding may be more severe in the event of wood or debris jamming at the culvert barrels. Replacement of these culverts with an adequately sized bridge span may help preserve access to this critical facility during flood events and in their aftermath. Based on this analysis, a minimum span length of 80 feet is recommended, which meets NYSDEC stream crossing guidance of 1.25 times the river's bankfull width; detailed updated hydrologic and hydraulic analyses are recommended prior to replacement of or significant upgrades to this structure.

Figure 4-24: West Haverstraw DPW Facility Bridge

4.5 HIGH RISK AREA #5

HRA 5 is located in the town of Haverstraw upstream of the intersection of Call Hollow Road and Willow Grove Road (vicinity of STA 360+00) and is depicted on Figure 4-25. The NAACC crossing code for the Call Hollow Road bridge is *xy4121954374044326,* and it was evaluated as being an *insignificant barrier* to fish passage with a NAACC aquatic passability score of 0.86 out of 1.0. Minisceongo Creek has a drainage area of 6.16 square miles at this location. No FEMA hydraulic modeling is available for this section of the creek. Therefore, a geomorphic assessment was conducted to develop flood mitigation recommendations.

Minisceongo Creek flows out of Lake Welch and through a steep, confined gorge before entering HRA 5. As Minisceongo Creek approaches Action Metal Company and Willow Grove Mobile Home Park, the channel exhibits a sharp decrease in slope (from approximately 11.9 percent to 1.7 percent, see Figure 4-26) and a widening river valley. These stream characteristics create a very dynamic environment (see Figure 4-27) due to the large volume of sediment and debris that tends to deposit in these settings during large floods. Minisceongo Creek transitions from a steep, high energy, confined stream as it flows through the gorge, to an unconfined, dynamic setting as the channel abruptly flattens upstream of Willow Grove Mobile Home Park, to a highly channelized and confined setting as it passes alongside Willow Grove Mobile Home Park and flows alongside and under Call Hollow Road.

As the creek passes alongside Willow Grove Mobile Home Park, gabion block walls that line the banks have been undermined and have toppled into the creek (Figure 4-28). Regional regression equations indicate that the bankfull geometry of Minisceongo Creek in this area should have a width of approximately 60 feet while the measured channel width as the creek passes between Willow Grove Mobile Home Park and Call Hollow Road is a mere 30 feet (Figure 4-29) and lacks a floodplain. The stream crossing at Call Hollow Road is also inadequately sized and is positioned at a poor angle relative to the creek.

Improvements in HRA 5 should begin with the acquisition and relocation of Willow Grove Mobile Home Park, which would be transitioned to a town-owned, publicly accessible floodplain park or greenspace and would allow adequate space for channel restoration. Channel and floodplain restoration and channel realignment are recommended along 1,200 linear feet of channel, beginning just downstream of the Action Metal Company and continuing to several hundred feet downstream of the Call Hollow Road crossing. Gabion blocks and other bank armoring that currently lines the channel should be removed. The restored channel should include a multistage channel with a width of 60 feet and a floodplain ranging in width from 50 to 150 feet, as available space allows. Regional regressions indicate an estimated bankfull depth of 2.4 feet at this location. In order to activate the proposed floodplain in this discharge, between 7 feet and 9 feet of overbank excavation is necessary where the creek is especially entrenched from approximately STA 362+00 to STA 371+00. From there, upstream to STA 375+00, only up to about 2 feet of excavation is required as this area of floodplain is currently more accessible. Hard bends in the channel should be eliminated. It is recommended that the stream crossing at Call Hollow Road be replaced with a bridge with a span of at least 60 feet and positioned at a better angle relative to Minisceongo Creek. A concept showing the recommended improvements is depicted in Figure 4-30.

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FIG. 4-25

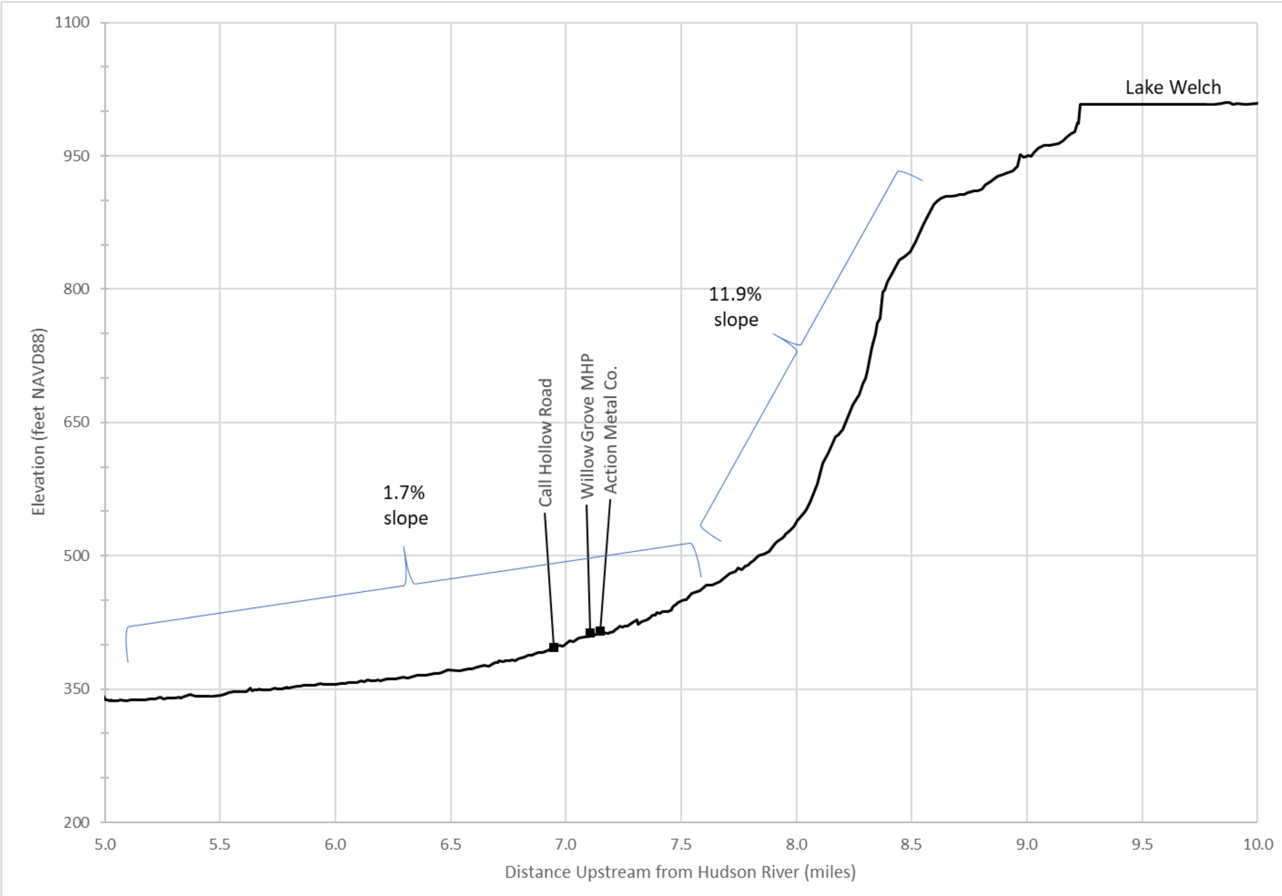

Figure 4-26: Longitudinal Profile of Minisceongo Creek through HRA 5

Figure 4-27: Dynamic Channel Upstream of Willow Grove Mobile Home Park

Figure 4-28: Gabions Falling into Minisceongo Creek Adjacent to Willow Grove Mobile Home Park

Figure 4-29: Confined Channel between Call Hollow Road and Willow Grove Mobile Home Park

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MINISCEONGO CREEK HIGH RISK AREA #5 CONCEPT MAP
MINISCEONGO CREEK FLOOD & RESILIENCY STUDY
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FIG. 4-30

4.6 HIGH RISK AREA #6

HRA 6 is the crossing of US Route 202 over South Branch Minisceongo Creek near STA 118+00 (Figure 4-32). It is located adjacent to the Pacesetter Park Shopping Center. The structure NAACC crossing code is *xy4118398074045906,* and it was evaluated as being an *insignificant barrier* to fish passage with a NAACC aquatic passability score of 0.90 out of 1.0. This crossing consists of dual concrete box culverts with a headwall and flared wingwalls built in 1956 (Figure 4-31). Each box has an 8-foot span and a 4.5-foot rise and has a watershed drainage area of 2.4 square miles. The hydraulic performance of each stream crossing was investigated using the Federal Highway Administration's (FHWA) *HY-8 Culvert Hydraulic Analysis* program.

The hydraulic modeling analysis indicates that the combined capacity of these culverts is 597 cubic feet per second (cfs), which is above the existing and future 100-year peak discharges of 515 cfs and 572 cfs, respectively. This finding indicates that the culverts are not a severe hydraulic constriction and do not contribute to flooding of the road. In addition, a debris jam sensitivity analysis was conducted to understand the impact of debris accumulation at the culvert inlet as observed in the field. Modeling this scenario showed that if either box opening was blocked by 50 percent the total capacity would be reduced to 352 cfs, or 60 percent lower than the unobstructed condition. Roadway overtopping would begin at the 25-year storm, with a likelihood that upstream businesses would be flooded. The peak flow values used in this assessment are summarized in Table 4-3.

Figure 4-31: Inlet of Stream Crossing Structure under US Route 202

Because this culvert is adequate for clear water flood conditions, regular maintenance of the structure, including both scheduled and postflood debris clearing, is recommended for the remainder of its service life. When due for replacement, detailed hydrologic and hydraulic analyses should be performed prior to design. Based on this analysis, a minimum single-span crossing of 39 feet is recommended, which meets NYSDEC stream crossing guidelines and is less susceptible to debris jamming.

Table 4-3: Modeled Peak Flow Discharges at US Route 202 Crossing

Recurrence Interval (Years)	Regional Regression Peak Flow (cfs)	Future Peak Flows (cfs)	Percent Increase
5-YR	167	182	9%
10-YR	230	252	10%
25-YR	327	361	10%
50-YR	415	459	11%
100-YR	515	572	11%

cfs = cubic feet per second

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MINISCEONGO CREEK HIGH RISK AREA #6

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FIG. 4-32

4.7 HIGH RISK AREA #7

HRA 7 is located in the town of Ramapo (Figure 4-34). South Camp Hill Road crosses over South Branch of Minisceongo Creek two times just north of Pomona Road. The upstreammost structure is located near STA 190+00, its NAACC crossing code is *xy4116843174049633,* and it was evaluated as being a *minor barrier* to fish passage with a NAACC aquatic passability score of 0.80 out of 1.0. The downstreammost structure is approximately 650 feet downstream near STA 183+50, its NAACC crossing code is *xy4116998574050192,* and it was evaluated as being a *minor barrier* to fish passage with a NAACC aquatic passability score of 0.78 out of 1.0. The hydraulic performance of each stream crossing was investigated using the FHWA's *HY-8 Culvert Hydraulic Analysis* program. The existing structures under South Camphill Road consist of three, 5-foot-diameter, circular corrugated metal culverts with a concrete headwall (Figure 4-33).

Figure 4-33: Inlet of Upstream Culverts (Left) and Outlet of Downstream Culverts (Right) on South Camphill Road

According to the analysis, the current capacity for either crossing is between the modeled 10- and 25-year peak discharges, at which point the structures become overwhelmed and roadway overtopping occurs. Under future flow conditions, peak discharge would marginally reduce the current capacity of each structure closer to a 10-year-magnitude event. The peak flow values used in this assessment are listed in Table 4-4.

Table 4-4: Modeled Peak Flow Discharges along South Camphill Road

Recurrence Interval (Years)	Regional Regression Peak Flow (cfs)		Future Peak Flows (cfs)		Percent Increase	
	South Camphill Road Culvert (Upstream)	South Camphill Road Culvert (Downstream)	South Camphill Road Culvert (Upstream)	South Camphill Road Culvert (Downstream)	South Camphill Road Culvert (Upstream)	South Camphill Road Culvert (Downstream)
5-YR	257	276	279	300	9%	9%
10-YR	354	380	387	415	9%	9%
25-YR	499	536	548	588	10%	10%
50-YR	626	671	689	739	10%	10%
100-YR	767	823	848	909	11%	10%

cfs = cubic feet per second

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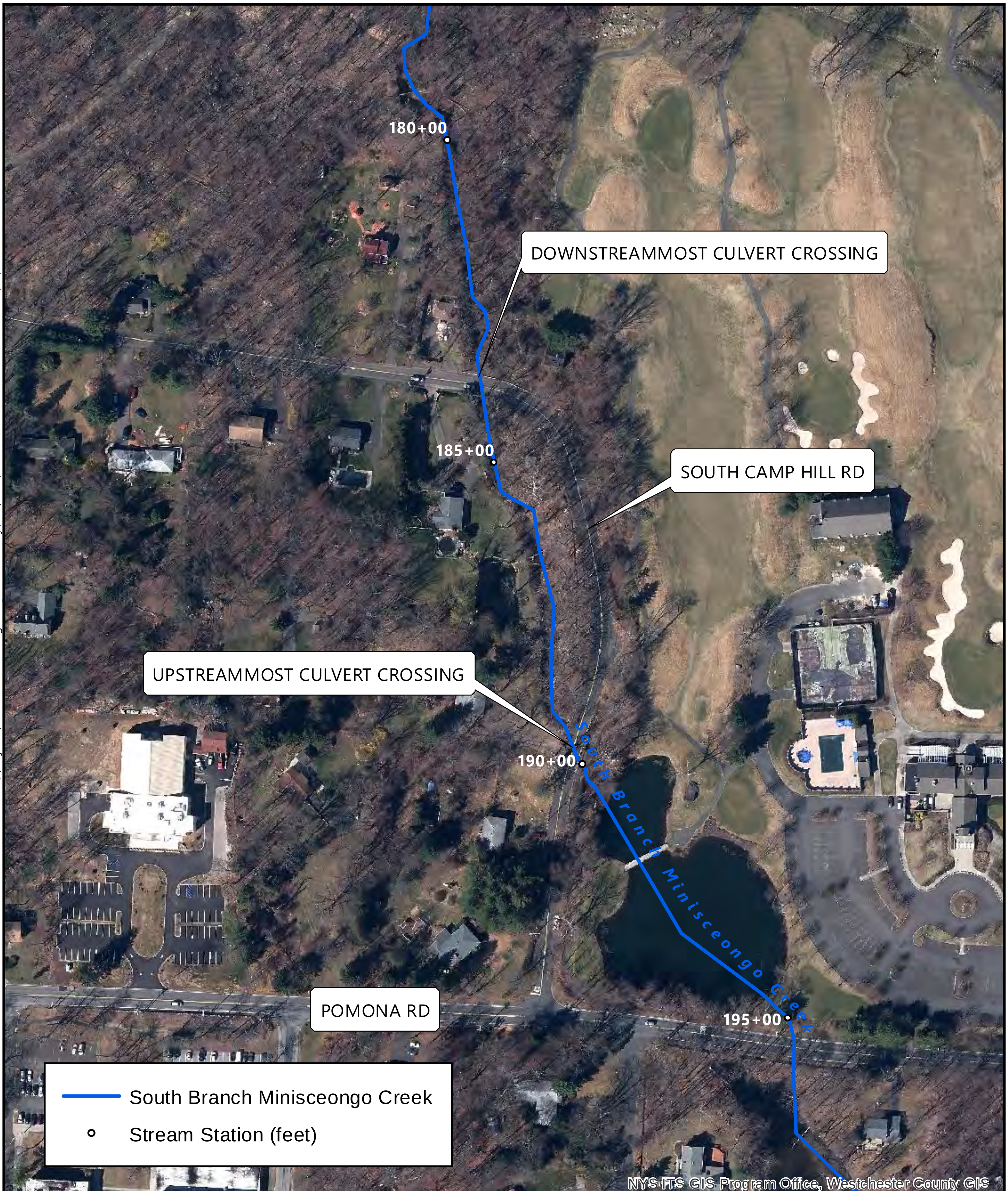

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MINISCEONGO CREEK HIGH RISK AREA #7

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NEW YORK

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FIG. 4-34

According to the NYSDOT *Highway Drainage Manual*, as a Functional Class 17, Urban Major Collector, crossings of South Camphill Road should be capable of conveying the 50-year flood discharge (NYSDOT 2018). An alternatives analysis was performed at each culvert to determine the necessary culvert dimensions required to fully convey the predicted future 50-year peak flow. Using this design criterion, the upstreammost culvert on South Camphill Road would need to be replaced with an 18-foot-span, 6-foot-rise, concrete box culvert with wingwalls. Additionally, the slope through the culvert would need to be steepened to enhance flow conveyance and improve the transition between the upstream and downstream portions of channel. This proposed scenario would reduce upstream water surface elevations by 1.7 feet during the 50-year storm, keeping floodwaters from spilling over the roadway.

Replacing the downstreammost culverts on South Camphill Road with a 21-foot-span, 5-foot-rise, concrete box culvert with wingwalls would pass the future 50-year design flood. Like the crossing located upstream, adjustments to culvert pitch and the channel shape downstream would be necessary to accommodate the replacement structure size and to properly convey the design flow. Modeling indicates that a larger structure may be capable of passing the 100-year flood discharge, but because non-flood-prone detours are available and loss of service of either or both structures would not leave any homes or businesses stranded or cut off from emergency access, the additional expense associated with conveying this flow is not likely to be warranted.

The existing total discharge capacity of each crossing along South Camphill Road and the replacement structure details are summarized in Table 4-5. The dimensions for these structures considered available room and the road profile at each crossing. For example, at the downstreammost crossing, there is very little road fill material above the existing culvert, and increasing the height of the culvert would require elevating the adjacent roadway as well. Other construction constraints such as underground utilities were not considered in this analysis.

Table 4-5: Summary of Findings for Culverts under South Camphill Road

	South Camphill Road Culvert (Upstream)	South Camphill Road Culvert (Downstream)
Existing Culvert Type	Three 5-foot-diameter corrugated metal pipes with concrete headwall	Three 5-foot-diameter corrugated metal pipes with concrete headwall
Existing 50-Year Peak Flow	626 cfs	671 cfs
Existing Total Capacity	468 cfs	407 cfs
Future 50-Year Peak Flow	689 cfs	739 cfs
Proposed Culvert Type	18-foot-span, 6-foot-rise, concrete box culvert with 35-75° wingwalls and headwall	21-foot-span, 5-foot-rise, concrete box culvert with 35-75° wingwalls and headwall
Proposed Total Capacity	728 cfs	745 cfs

cfs = cubic feet per second

5. RECOMMENDATIONS

Minisceongo Creek originates in west central Rockland County and drains eastward to the Hudson River Estuary. This report identifies HRAs within the Minisceongo Creek watershed. Flood mitigation recommendations are provided either as HRA-specific recommendations or as overarching recommendations that apply to the entire watershed or stream corridor. Flood mitigation scenarios such as floodplain enhancement and channel restoration, road closures, and replacement of undersized bridges and culverts are investigated and are recommended where appropriate.

5.1 HRA 1 RECOMMENDATIONS

Replacement of the twin-barreled, four-sided box culvert that carries Route 9W across Minisceongo Creek with an adequately sized bridge span with accompanying detailed hydrologic and hydraulic analyses is recommended. The most current regulations and guidance from NYSDOT and NYSDEC regarding stream crossing geometry and hydraulic performance should be applied, as well as updated assessments of projected future flows. Based on the foregoing assessment, a 130-foot single-span bridge is recommended.

Creation of floodplain up to 50 feet in width is recommended along the left bank of approximately 2,700 linear feet of the Minisceongo Creek channel, beginning approximately 500 feet downstream of the GAIC and ending 600 feet downstream of the 9W crossing. Sized to flow about 1 foot deep in the 10-year flood, up to about 15 feet of overbank excavation is necessary for this 3.1-acre floodplain area. A conceptual layout of the proposed floodplain bench is depicted in Section 4.1, Figure 4-5 of this report.

If the proposed floodplain benching cannot be implemented concurrently with bridge replacement, sizing the new bridge with adequate span such that it is able to accommodate this additional width is recommended so that it can be incorporated in the future.

5.2 HRA 2 RECOMMENDATIONS

Both construction of the proposed floodplain benching at the Viohl Park site and removal of the western portion of the floor of Building #26A at the GAIC are recommended. These provide the greatest flood mitigation benefits to the Church Street and West Railroad Avenue/GAIC neighborhoods with minimal disruption to the operation and character of either the park or the Arts Center. Marginally greater benefits are achievable, but these require extensive disturbances that may negatively impact operations at the GAIC. The owners of Building 26A have reported that removal of the western portion of the floor had already been under consideration, if grant funding were available, to alleviate nuisance debris jamming upon its piers. Because modeling has demonstrated that there are additional significant and far-reaching flood mitigation benefits, which can also help to bring the Bridge Street dam into regulatory compliance, removing a portion of the floor of this building presents itself as a particularly effective and viable alternative and is recommended for implementation. The Viohl Park floodplain bench has merit as a stand-alone project although its benefits would be expected to increase considerably when performed in combination with the removal of Building 26A downstream. The floodplain bench at Viohl Park, which would require between 4 feet and 6 feet of excavation along 250 linear feet of Minisceongo Creek, is depicted as a conceptual layout in Section 4.2, Figure 4-12 of this report.

It is recommended that Bergmann Engineers' Suffern Lane dam removal feasibility study be followed up by design and construction of the preferred alternative, whether wholesale removal or lowering of the spillway crest elevation, thus eliminating or greatly reducing the hazard associated with dam overtopping and failure. Because these alternatives may also facilitate decreasing the Garnerville Dam's hazard classification to Class A, for which it can pass the SDF, removal of the Suffern Lane dam can have the additional benefit of helping to bring the Garnerville Dam into regulatory compliance.

5.3 HRA 3 RECOMMENDATIONS

Following further, detailed hydrologic and hydraulic analyses, design and construction of the proposed 550-foot-long, 60-foot-wide floodplain bench along Minisceongo's right (south) bank where it flows along the north side of the Thiells School are recommended. Required excavation begins at about 1 foot at the upstream end and increases downstream as it matches the natural channel slope, up to about 6 feet at the downstream end of the proposed floodplain, for a total of roughly 5,500 CY of export. Under this scenario, flooding of the elementary school would no longer be expected in the current or projected future 100-year floods; depending on the location, orientation, and elevation of doors, windows, and ventilation intakes, very minor floodproofing measures can further alleviate flooding of the school in the 500-year event. A conceptual layout of the floodplain bench along Minisceongo Creek is depicted in Section 4.3, Figure 4-15 of this report.

5.4 HRA 4 RECOMMENDATIONS

5.4.1 PALISADES INTERSTATE PARKWAY EXIT 14 NORTHBOUND AND WILLOW GROVE ROAD

A consultation with emergency services providers is recommended to determine whether alleviating flooding of the northbound Exit 14 on/off ramp for the PIP is critical for maintaining emergency response and life safety networks. The southbound on/off ramp does not appear to be flood prone, and an authorized-vehicle U-turn is located just one-third of a mile south of the southbound on ramp. With appropriate planning, a massive capital investment on the northbound on ramp may not be warranted when such a minor detour is available. That being said, the detour length for members of the public would be significantly greater although preparation and appropriate signage may be sufficient in the event of a flood forecast. Because Willow Grove Road would also be expected to flood in most events where the PIP exit ramp overtops, travel is likely to be limited in this area under such conditions regardless. While conveying the overbank flow in a 100-year discharge through culverts under the exit ramp may not be practical, less substantial upgrades in floodplain relief capacity may help to alleviate shallow nuisance flooding in less extreme high water events. When the northbound on-ramp bridge is due for replacement, an updated detailed hydrologic and hydraulic analysis is recommended. The most current regulations and guidance from NYSDOT and NYSDEC regarding stream crossing geometry and hydraulic performance should be applied, as well as updated assessments of projected future flows. Based on this analysis, a minimum span length of 75 feet is recommended, which meets NYSDEC stream crossing guidance of 1.25 times the river's bankfull width.

Due to vehicle clearance limitations on Willow Grove Road underneath the PIP, raising the road to reduce flooding or realigning the road to ease the contraction and provide a broader stream channel here is not likely feasible. When the current PIP bridge over Willow Grove Road and Minisceongo Creek is due for replacement or significant upgrade, it is recommended that consideration be given to alleviating flooding of the roadway below.

5.4.2 STORRS ROAD – WILLOW GROVE ELEMENTARY SCHOOL AND FIELDSTONE MIDDLE SCHOOL

When the Storrs Road bridge is due for replacement, it is recommended that the feasibility of relocating the structure and realigning Storrs Road be explored, as this may require less of a capital investment than preventing roadway overtopping with the existing alignment. If replaced in-place, a minimum span length of 80 feet is recommended, which meets NYSDEC stream crossing guidance of 1.25 times the river's bankfull width. Replacement should be accompanied by an updated detailed hydrologic and hydraulic analysis. The most current regulations and guidance from NYSDOT and NYSDEC regarding stream crossing geometry and hydraulic performance should be applied, as well as updated assessments of projected future flows. Although likely impractical for the most severe floods, more modest upgrades in floodplain relief capacity may alleviate nuisance roadway overtopping in the more common high flows.

5.4.3 ROCKLAND PRINT COMPANY POWER PLANT BRIDGE

Removal of the derelict bridge crossing at the Rockland Print Company power plant is recommended as it is unnecessary, unused, and ostensibly unsafe. The bridge obstructs flow, can snag debris on its piers, and is such a massive monolith of concrete that its failure and collapse into the creek could have severe consequences.

5.4.4 WEST HAVERSTRAW DEPARTMENT OF PUBLIC WORKS ACCESS ROAD

Upgrading the 4WD Road culvert that provides access to the Haverstraw DPW is recommended when the structure is due for replacement or significant repair. While this is a critical facility, there is not an urgent need to upgrade this crossing due to an alternative access to the site from the northeast. A single-span bridge that is less susceptible to debris jamming is recommended, along with appropriate reconfiguration of the existing sanitary utility crossing. A minimum span length of 80 feet is recommended, which meets NYSDEC stream crossing guidance of 1.25 times the river's bankfull width. When due for replacement, an updated detailed hydrologic and hydraulic analysis is recommended. The most current regulations and guidance from NYSDOT and NYSDEC regarding stream crossing geometry and hydraulic performance should be applied, as well as updated assessments of projected future flows.

5.5 HRA 5 RECOMMENDATIONS

It is recommended that improvements in HRA 5 begin with the acquisition and relocation of Willow Grove Mobile Home Park, which would be transitioned to a town-owned, publicly accessible floodplain park or greenspace.

Channel and floodplain restoration and channel realignment are recommended along 1,200 linear feet of channel, beginning just downstream of the Action Metal Company and continuing to several hundred feet downstream of the Call Hollow Road crossing.

The restored channel should include a multi-stage channel with a width of 60 feet and a floodplain ranging in width from 50 to 150 feet, as available space allows. Hard bends in the channel should be eliminated. It is recommended that gabion blocks and other bank armoring that currently lines the channel be removed.

It is recommended that the stream crossing at Call Hollow Road be replaced with a bridge with a span of at least 60 feet and positioned at a better angle relative to Minisceongo Creek. Prior to replacement, an updated detailed hydrologic and hydraulic analysis is recommended. The most current regulations and guidance from NYSDOT and NYSDEC regarding stream crossing geometry and hydraulic performance should be applied, as well as updated assessments of projected future flows.

A concept showing the recommended improvements at HRA 5 is depicted in Section 4.5, Figure 4-30 of this report.

5.6 HRA 6 RECOMMENDATIONS

The crossing of US Route 202 over South Branch Minisceongo Creek was found to be adequately sized to accommodate the existing and future 100-year peak discharges under clear flow conditions, indicating that the culverts are not a severe hydraulic constriction and do not contribute to flooding of the road. However, the crossing may be prone to debris jamming, which reduces the hydraulic capacity. It is recommended that regularly scheduled inspections continue and that poststorm inspections be incorporated to remove any debris accumulation that reduces the capacity of this structure.

At the end of the current structure's service life, replacement with an adequately sized, single-span bridge or box culvert is recommended to reduce the potential for debris jamming as this can significantly interfere with the culvert's performance. Based on a 31-foot bankfull width estimated by regional regressions, a minimum span of 39 feet would be recommended, which meets the NYSDEC guideline of stream crossings spanning 1.25 times the bankfull width When the culvert is due for replacement, an updated detailed hydrologic and hydraulic analysis is recommended. The most current regulations and guidance from NYSDOT and NYSDEC regarding stream crossing geometry and hydraulic performance should be applied, as well as updated assessments of projected future flows.

5.7 HRA 7 RECOMMENDATIONS

In HRA 7 at the South Camp Hill Road crossings over South Branch of Minisceongo Creek, it is recommended that the upstream culverts on South Camphill Road be replaced with an 18-foot-span, 6-foot-rise, concrete box culvert with wingwalls. Additionally, the slope through the culvert should be steepened to enhance flow conveyance and improve the transition between the upstream and downstream portions of the channel.

It is recommended to replace the downstream culverts on South Camphill Road with a 21-foot-span, 5-foot-rise, concrete box culvert with wingwalls. Like the upstream crossing, adjustments to culvert pitch and the channel shape downstream would be necessary to accommodate the replacement structure size and to properly convey the design flow. Any improvements should be carried out with accompanying detailed hydrologic and hydraulic analyses.

When these culverts are due for replacement, an updated detailed hydrologic and hydraulic analysis is recommended. The most current regulations and guidance from NYSDOT and NYSDEC regarding stream crossing geometry and hydraulic performance should be applied, as well as updated assessments of projected future flows.

5.8 REPLACEMENT OF UNDERSIZED STREAM CROSSINGS

Hydraulically undersized stream crossings contribute to flooding and washout of roadways. In addition to the recommendations for the replacement of stream crossings within the HRAs described above, it is recommended that undersized stream crossings elsewhere in the Minisceongo Creek watershed be identified and prioritized for replacement. Guidance for this prioritization should be based on capacity modeling and aquatic organism passage data for culverts in Rockland County that have been assessed through the NAACC program. Where multiple stream crossings are slated for replacement along a reach of watercourse, it is recommended that replacements begin at the downstream end and progress sequentially in an upstream direction.

5.9 UPDATED FEMA HYDRAULIC MODELING

FEMA hydraulic modeling for Minisceongo Creek above its confluence with the South Branch, and for the South Branch, is based on antiquated HEC-2 analysis dating from the 1980s. It is recommended that new FEMA modeling for these areas be developed to reflect current hydraulic and hydrologic conditions. The updated hydraulic modeling would reflect changes such as bridge replacements, flood mitigation projects, or updated flood hydrology.

5.10 INSTALLATION AND MONITORING OF STREAM GAUGE

There is currently no stream gauge on Minisceongo Creek or South Branch, making statistical analysis difficult. Stream gauges provide valuable data that can be used in future hydrologic analyses and to improve flood monitoring and forecasting. Installation of a permanent stream gauge is recommended.

5.11 INDIVIDUAL PROPERTY FLOOD PROTECTION

A variety of measures is available to protect existing public and private properties from flood damage. While broader mitigation efforts are most desirable, they often take time and money to implement. On a case-by-case basis where structures are at risk, individual floodproofing should be explored. Property owners within FEMA-delineated floodplains should also be encouraged to purchase flood insurance under the NFIP and to make claims when damage occurs. Potential measures for property protection include the following:

Elevation of the structure – Home elevation involves the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located at least 2 feet 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.

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 basin where implementation of such measures will serve to protect structures.

Dry floodproofing of the structure to keep floodwaters from entering – Dry floodproofing refers to the act of making areas below the flood level watertight and is typically implemented for commercial buildings that would be unoccupied during a flood event. Walls may be coated with compound or plastic sheathing. Openings such as windows and vents can 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. Wet floodproofing should only be used as a last resort. If considered, furniture and electrical appliances should be moved away or elevated above the 100-year flood elevation.

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 (if the ceiling permits). A wooden platform of pressure-treated wood can serve as the base.
- Anchor the fuel tank to the wall or floor with noncorrosive metal strapping and lag bolts.
- Install a backflow valve to prevent sewer backup into the home.
- Install a floating floor drain plug at the lowest point of the lowest finished floor.
- Elevate the electrical box or relocate it to a higher floor and elevate electric outlets.

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 in order to increase the eligibility of the property for projects under the various mitigation grant programs.

5.12 ROAD CLOSURES

Approximately 75 percent of all flood fatalities occur in vehicles. Shallow water flowing across a flooded roadway can be deceptively swift and wash a vehicle off the road. Water over a roadway can conceal a washed out section of roadway or bridge. When a roadway is flooded, travelers should not take the chance of attempting to cross the flooded area. It is not possible to tell if a flooded road is safe to cross just by looking at it.

One way to reduce the risks associated with the flooding of roadways is their closure during flooding events, which requires effective signage, road closure barriers, and consideration of alternative routes.

According to FEMA modeling and anecdotal reporting, flood-prone roads exist within the Minisceongo Creek watershed. In some cases, small, unnamed tributaries and even roadside drainage ditches can cause washouts or other significant damage to roadways, culverts, and bridges. Drainage issues and flooding of smaller tributary streams are generally not reflected in FEMA modeling, so local public works and highway departments are often the best resource for identifying priority areas and repetitively damaged infrastructure.

In HRA 4 where Willow Grove Road passes underneath the PIP, raising or realigning the road to reduce flooding and provide a broader stream channel is not likely feasible. When the current PIP bridge over Willow Grove Road and Minisceongo Creek is due for replacement or significant upgrade, it is recommended that consideration be given to alleviating flooding of the roadway. Until infrastructure improvements can be made, the implementation of effective signage, road closure barriers, and consideration of alternative routes are recommended.

To assist with prioritization of the above recommendations, Table 5-1 provides an estimated cost range for key recommendations.

Table 5-1: Cost Range of Recommended Actions

	< $100k	$100k - $500k	$500k - $1M	$1M - $5M	> $5M
HRA 1 - Route 9W bridge and floodplain					X
HRA 2 - Removal of Building #26A at GAIC				X	
HRA 2 - Floodplain benching at Viohl Park				X	
HRA 2 - Suffern Lane dam removal or lowering				X	
HRA 3 – Floodplain bench at Thiells School				X	
HRA 4 – Storrs Road bridge replacement and realignment				X	
HRA 4 – Removal of derelict bridge crossing			X		
HRA 4 - Upgrading 4WD Road crossing				X	
HRA 5 - Channel and floodplain restoration and bridge replacement					X
HRA 6 – Route 202 crossing inspection and maintenance	X				
HRA 7 - South Camp Hill Road crossing (upstream)		X			
HRA 7 - South Camp Hill Road crossing (downstream)		X			

6. LAND USE ANALYSIS

6.1 LAND USE AND ZONING REVIEW AND ANALYSIS

Potential changes to land use, particularly development proposals in close proximity to a waterbody or within a riparian buffer, can bring about issues and consequences not only for the impact on those developments should a flood occur but also as a contributor to the flooding problem itself. In NYS, land use is controlled at the municipal level through zoning, subdivision, and other related regulations including wetlands and floodplain ordinances.

In Rockland County, there has been a significant amount of work conducted by the state, county, and local municipalities, typically following a flood event such as Tropical Storm Irene or Superstorm Sandy, which creates an immediate need to respond to the disaster as well as an understanding that situations surrounding such disasters need to be assessed and plans developed to mitigate likely future repeat events.

One agency in Rockland County that has regulatory jurisdiction over activities within 100 feet of specified streams, including portions of Minisceongo Creek, is the Rockland County Drainage Agency.

http://rocklandgov.com/departments/highway/drainage-agency/

This analysis reviewed publicly available project-relevant documents found online to identify recommendations and opportunities identified for communities to address issues related to flooding through land use and zoning. This analysis also provides "best practice" recommendations that communities in Rockland County can review and discuss implementing if not already in the municipal code. A significant and positive finding from this effort is that every community assessed within the Minisceongo Creek watershed has adopted a Flood Damage Prevention Ordinance. These ordinances, generally adopted in 2013 and 2014, go a long way toward addressing potential issues and concerns related to flooding and land use planning.

Review of the following documents did not find any municipal-specific land use or zoning recommendations to carry forward for this project. We have summarized recommendations related specifically to flooding that may be useful to consider when assessing potential changes to existing zoning, subdivision, and other regulations that could impact flood-related conditions:

- *Hudson River Estuary Habitat Restoration Plan - NYSDEC* (2013)

    - This plan identifies priority habitats vital to the health and resiliency of the estuary and actions for restoring them. The plan states that it is "…the basis for coordinating funding, planning, research and implementation of resources toward a single, focused goal: The enduring health and wellbeing of the Hudson River estuary, its inhabitants and the people of the Hudson River Valley and New York State." It states that despite improvements in the Hudson River there "…remains a profound need for habitat restoration." There was nothing specific to Rockland County communities identified in this plan. That said, riparian buffer protections and related protections of vital habitats by municipalities will generally assist with the implementation and protection efforts identified and desired by this plan.

- All Rockland County communities have a flood damage prevention ordinance. The standards adopted can vary from community to community, but they all provide construction standards for actions within flood hazard areas.

- All Rockland County communities are under the "umbrella" of the 2011 Rockland County Comprehensive Plan *Rockland Tomorrow: County Comprehensive Plan.* There are only a few specific mentions or recommendations related to flooding and flood prevention for individual municipalities, but where such a mention is made, it is included under that community below. All communities fall within the following recommendations from the plan:

    - Land Use and Zoning Chapter
        - ➢ No key issues identified.
    - Natural Resources Chapter – Encourage the municipalities to establish buffers along streams as appropriate, with the specific distance dictated by conditions on the ground and scientific study.
    - Infrastructure Chapter – Use planning techniques for green infrastructure and stormwater management, as provided by the NYSDEC.

- *Cleaner, Greener Communities Mid-Hudson Regional Sustainability Plan (Mid-Hudson Planning Consortium)* 2013

    - This plan was developed to "…set realistic yet ambitious objectives for the long term sustainable development of the Region, each of which is supported by initiatives and projects that can be implemented in the short-, medium-, and long-term." The plan lists 218 project ideas, some of which are directed toward Rockland County specifically, but none of those projects is flood or land use/zoning focused. That said, there are Mid-Hudson-wide recommended projects related to flooding that are relevant including the following:

        - ➢ Project 6 – Scenic Hudson is working with 16 land trusts and government agencies to save ridgelines with iconic views, forests, and wetlands critical to maintaining the Hudson Valley's extraordinary biological diversity and farmland.
        - ➢ Project 44 – Hudson River Greenway Water Trail – a 256-mile, 96-site water trail for kayakers and boaters extending from the Adirondack Park and Lake Champlain to Manhattan
        - ➢ Project 63 – Install porous pavement in municipalities.
        - ➢ Project 188 – Increases in the extent of riparian buffers
        - ➢ Project 203 – Watershed remediation. This project will help identify and target funds to specific vulnerable locations to protect roads and other facilities from flooding.

- ➢ Project 212 – Get municipalities involved in green infrastructure. Enable more green infrastructure projects by removing cost and knowledge barriers.

- *Rockland County Hazard Mitigation Plan (hmp)*

  - This plan "…demonstrates county and community commitment to reducing risks from all hazards and serves as a guide for decision makers as they commit resources to minimize the effects of hazards. The HMP is the blueprint for reducing the county's vulnerability to disasters and hazards. The HMP is intended to integrate with county and municipal planning mechanisms already in place, such as building and zoning regulations, environmental planning, and long-range planning mechanisms."

    - ➢ All Rockland County communities had a Jurisdictional Annex developed detailing information about their community. A summary of the relevant information from these Annexes is provided below.

6.2 MUNICIPAL ASSESSMENTS

The following section details each community being assessed within the Minisceongo Creek watershed. A map with the boundaries of the Minisceongo Creek watershed and the towns and villages that fall within it is depicted in Figure 6-1. In Section 6 of this report are "best practices" that each community can review to assess whether or not they are already in their municipal code or are an opportunity to enhance the code to further protect municipal resources, residents, businesses, and the natural environment from unplanned and unwanted impacts from flooding.

6.2.1 TOWN OF STONY POINT

Zoning & Other Code(s) Analysis

https://ecode360.com/11119275

The code includes a "Flood Damage Prevention Ordinance" (Chapter 112). This Chapter has standards related to elevation and flood-resistant construction. It also includes a "Freshwater Wetlands" code (Chapter 116), "Stormwater Management" code (Chapter 185), "Freshwater wetlands protection and buffer requirements" (Section 215-72), and floodplains regulations (Section 215-71) in the Zoning Ordinance, which notes that floodplains are further governed by Site Plan Review. The code also includes Section A220-8 Development in flood hazard areas.. *These three sections of the code provide significant regulation of what is and is not permitted in the flood hazard areas within the town.*

A Waterfront Zoning Amendment was drafted in 2015 that requires applicants to factor in FEMA BFEs and sea level rise into site design. The new zoning requires that building proposed as part of the Waterfront Mixed-Use development must be built at least 2 feet above BFE. *This is consistent with Best Practices detailed at the end of this section.*

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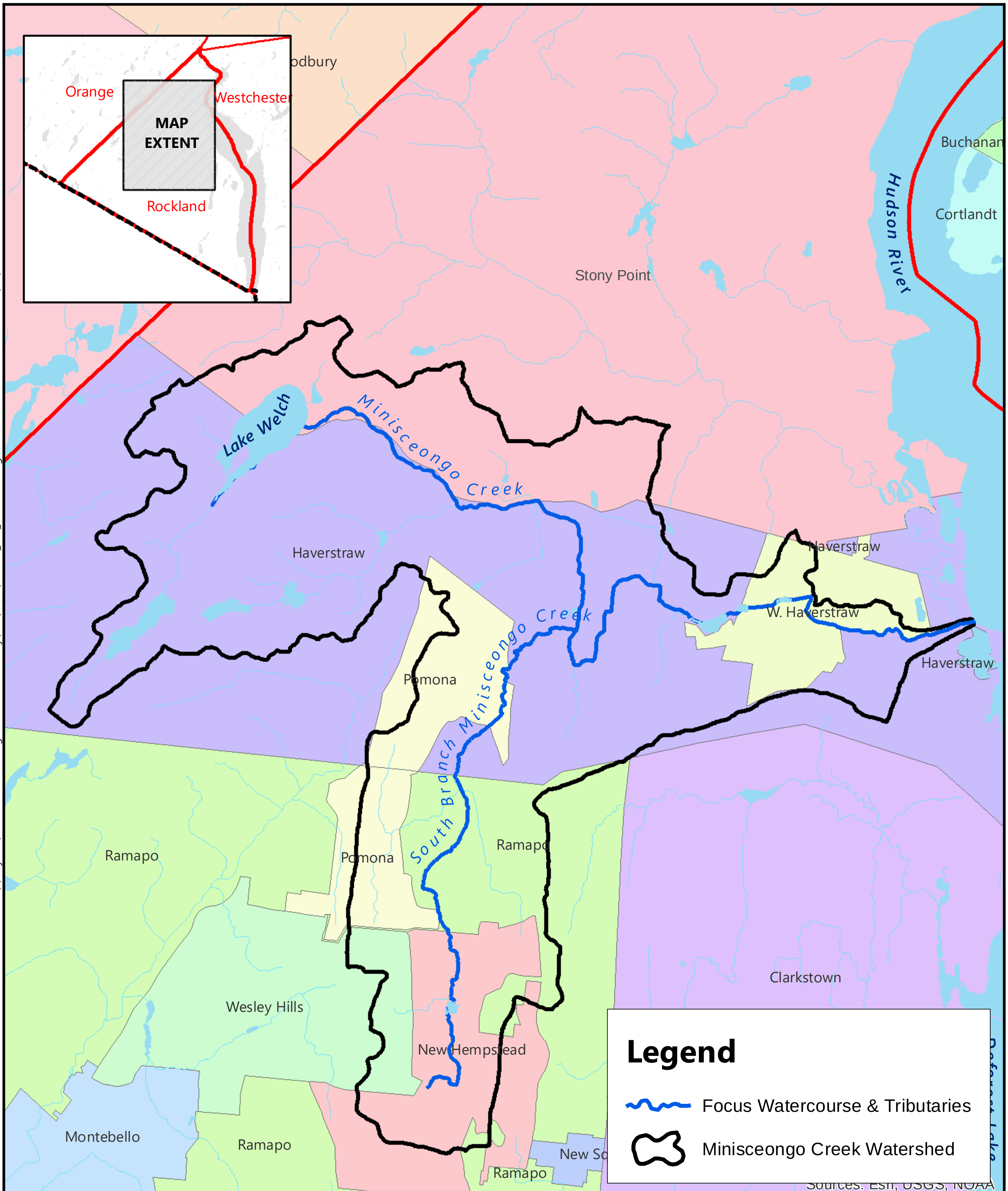

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231 MAIN STREET
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NEW PALTZ, NY 12561
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MINISCEONGO CREEK WATERSHED TOWNS & VILLAGES

MINISCEONGO CREEK FLOOD & RESILIENCY STUDY
SD112
ROCKLAND COUNTY
NEW YORK

N
0 2,500 5,000
Feet

SCALE 1 " = 6,000 '
DATE 3/31/2022
16511.00007
PROJ. NO.

FIG. 6-1

Other Land Use Documents Reviewed:

https://www.townofstonypoint.org/resilient-stony-point

The Town of Stony Point has undertaken several initiatives for becoming more resilient, many of which are available on the municipal website at https://www.townofstonypoint.com/resilient-stony-point.

- Flood Resilience Task Force –
  - The town is one of four communities to convene this task force. In 2014, the town convened a task force of local stakeholders who recommended 19 strategies for increasing the resilience of waterfront areas. The multitown task force began to meet in 2019.
- A Stony Point Task Force Final Report (*Report on Coastal Vulnerability and Sea Level Rise – December 8, 2014*) provided recommendations for six different physical or topical areas. The following land use or zoning recommendations were included:

  Beach Road/Stony Point Bay Area

  - Recommendation 2: Allow flexibility in height regulations to allow any future waterfront development to measure height from the base flood elevation or current existing grade, whichever is higher. Require any residential waterfront development to provide a strategy for mitigating possible sea level rise increases including incorporating wet flood proofing strategies or adapting construction to facilitate easier postconstruction height increase. *Based on a review of the existing Town Code, we did not see any flexibility in height for uses in the Planned Waterfront (PW) zoning district as heights are set as maximums by use group*. *Best practices recommendations detailed below specifically discuss reducing setback distances to permit buildings to cover more of a lot but at an elevation above the BFE (which is required per Section A220-8), as well as permitting higher structures to account for any loss of square footage that might otherwise be permitted below the BFE.*
  - Recommendation 3: Require any future large-scale Hudson River waterfront residential development to creatively address and mitigate access restrictions of the Tomkins Avenue underpass and Beach Road (possibly by locating emergency service equipment on-site). *We did not see specific regulations related to these two roadways though there are winter storage area limitations for where boats can be stored and associated access requirements.*

  BaMar Park Area

  - Recommendation 8: The Town should consider new legislation requiring minimum setbacks from mobile homes to the mean high water line of any tidal waterbody. Consideration should be given to limiting grandfathering of this standard. The setback area could be used for alternative uses such as recreation or marina use. Additionally, the setback could support construction of a berm, which could allow the owner of the park to seek a map amendment from FEMA, thereby lowering insurance costs. *The MHC Zoning District details regulations for Mobile Homes. As an h.5 use, we did not see any regulations specific to mobile homes related to minimum setbacks. The code does require setbacks to be measured from the mean high water line of the Hudson River.*

- Recommendation 10: Consider a TDR Program that funds buyouts of homes in exchange for residential density elsewhere in the Town. The Town should consider allowing private developers to purchase homes and lots within FEMA "V-zones" and in exchange for dedication of the land or easements to the Town, to be able to apply this density to any zoning district in the Town except for the APRP and SR districts. Details of the program would have to be developed including the maximum increase in density allowed under this program, and minimum lot sizes required for buyout, but it could provide revenue that the Town can use to buy out highly vulnerable properties with owners willing to sell. *We did not see a Transfer of Development Rights (TDR) program in the Zoning Code for the town.*

Climate Smart Communities Section

- Recommendation 14: Prepare a comprehensive update of the Town's Comprehensive Plan. The Plan should specifically include consideration of sea level rise and identify coastal resiliency as a goal. Flood-prone areas should be considered for open space and recreation and measures of acquiring private flood-prone lands should be explored. *The town's Comprehensive Plan was last updated in 2013 prior to the development of this document and therefore does not appear to have been updated per this recommendation.*
- Recommendation 17: Update the Local Waterfront Revitalization Plan (1994) and ensure it addresses sea level rise and coastal storms. The current Plan is dated both from a goal and from a resiliency standpoint. Updating the plan could make the Town eligible for additional public funding of resiliency infrastructure projects. *It does not appear that the 1994 Local Waterfront Revitalization Plan (LWRP) has been updated.*

Local Waterfront Revitalization Plan 1994

This plan listed several regulations that were related to the LWRP.

- Appendix E includes a Flood Damage Prevention Local Law. *Chapter 112 in the town Zoning Code was adopted in 2013.*
- Appendix F is local law #3 of 1994 deleting the Waterfront Planned Development (WPD) Zoning District and adding a new PW – Planned Waterfront District. *Section 215 Attachment 13 within which the PW Zoning District is included was last amended in 2015.*
- Appendix G lists additional land use standards which are to be handled as part of the Harbor Management Plan.
- Appendix D is amendments to the Freshwater Wetland law adopted in March 1993.

Comprehensive Master Plan - 2013 Amendment to the 1995 Plan

This plan detailed changes and revisions to the Town Code that have been made since 1995.

- Stream protection law had been implemented since the 1995 plan.
- Strict compliance with NYSDEC stormwater runoff has been implemented.
- Zoning and other policies were reviewed for consistency with the LWRP.
- Restricted more dense development to areas with adequate infrastructure.
- A mixed-use redevelopment project was proposed at a marina but could not be accomplished without major revisions to the town's zoning and flood management regulations. This area is desired for economic development but needs "…comprehensive, detailed planning and land use regulation to create a feasible and integrated community asset."

- Restaurants in the Waterfront Residential district (R-W) were desired, and changes to the code to permit such uses were considered but not adopted.
  - The stream protection law is difficult to understand. It needs to be updated to be easier to read without changing the substantive provisions. Maybe use illustrative examples?
  - Waterfront investments could include wetland restoration and other flood mitigation measures.
  - Recommends recommendations for appropriate uses, sizes, densities, and necessary public improvements and required environmental mitigations for areas including Kay Fries, Beach Road, the former Lovett power plant site, and Letchworth Village
  - The HMP states that there are no plans to update this document.

- *New York Rising Community Reconstruction Plan* 2014
  - The NY Rising Plan is a comprehensive study of flood risk and recommended implementation projects. Relevant land use and zoning recommendations included the following:
    - Housing: Restrictions on residential development and/or redevelopment as well as compliance with and enforcement of the existing building code in identified risk areas is needed, including for older housing units that are not legally required to meet the code. There is also a need to deal with abandoned, foreclosed, and damaged properties which have not been kept up since the storms. These properties are a safety hazard and an economic blight on the surrounding areas. <u>*Residential development is restricted to mixed use within the PW Zoning District and only as a Conditional Use.*</u>
    - Housing: There is also a need to revisit the Town's zoning code to ensure that resilient rebuilding can take place in the waterfront and other flood-prone areas. It is important to note that the Town recently adopted the FEMA advisory base flood elevations established after the recent storms into its local Flood Damage Prevention Law (Chapter 112 of the Town Code). *It appears that the Code has resiliency requirements incorporated into it through section in 215-72, Chapter 112 and Section A220-8 (as detailed above).* <u>*Additional potential revisions to incorporate Best Practices as noted below could be assessed and considered for revisions to the existing code.*</u>
    - Housing: A need exists to ensure the continued diversity of the Town's population by preserving the mixed income and multi-generational options that currently define Stony Point. Low-income residents experienced severe housing damages during Superstorm Sandy. <u>*This is primarily a policy issue that can partially be addressed through zoning regulation changes that may or may not directly impact flood areas and that are a townwide issue for consideration.*</u>
    - Economic Development: Develop a master plan for Grassy Point, which would address resiliency through methods to manage sea level rise. The plan would also seek to further public use, including tourism and education, and promote appropriate economic development and resilient water-dependent uses. The plan would consider both private and public lands on Grassy Point

and present a variety of potential future uses in conceptual form. $175,000 est. This project has medium community support – general support but some issues to resolve. *It does not appear that this project has been undertaken.*

- Strategy 5: Promote Sustainability and resilience through local land use planning.
  - The Town's existing Master Plan and Local Waterfront Revitalization Program (LWRP) can be tailored to cater to the vulnerabilities exposed by Superstorm Sandy, Tropical Storm Lee, and Hurricane Irene. Updates to LWRP and revised Master Plan (cost – $125,000 - $225,000) – The Town of Stony Point's Master Plan and Local Waterfront Revitalization Program (LWRP) are in need of updates to address sustainability, energy efficiency, resilience, and sea level rise. This project would initiate the public process required for updating these documents. In addition to the topics listed above, other ideas for improvements to these plans include incorporation of a Harbor Management Plan and a Marina Protection Plan to be employed during storm events. This project has medium community support – general support but some issues to resolve. *It does not appear that this project has been undertaken.*
  - The Committee feels that a comprehensive plan for the Grassy Point neighborhood would be an excellent vehicle for finding ways to strengthen the Town's waterfront economy while providing more open space and a more resilient and inclusive housing stock. *It does not appear that this project has been undertaken.*
  - Codifying the use of the latest flood resistant materials and building techniques. Improvements to local planning practices would also take the form of a marina protection and harbor management plan, and an examination of the zoning code to facilitate the rebuilding of damaged homes, buildings, and infrastructure. *It does not appear that this project has been undertaken. The existing LWRP includes a Harbor Management Plan, but it is from 1994 and likely needs updating.*
- Strategy 5: Assess Zoning Code for Rebuilding Requirements/Processes: This project would assess the Stony Point zoning code to determine if changes to the code would be required to ease the process of rebuilding homes, other buildings, and infrastructure in the floodplain. $25,000 - $50,000. This project has medium community support – general support but some issues to resolve. *It does not appear that this project has been undertaken. A summary of what the town has in its code has been assessed, and Best Practices are provided below that could help ease the process of rebuilding while also protecting the natural environment, riparian buffers, and floodplains.*

- *Rockland County Multi-Jurisdictional Natural Hazard Mitigation Plan Update* 2018
  - According to the FEMA Flood Insurance Study, flooding comes from Hudson River, Cedar Pond Brook, and Tributary to Cedar Pond Brook. Areas vulnerable include WW Treatment facility on North St., Beach Road and River Road on Hudson River, and Cedar Flats Road and Route 210. BaMar mobile home park is very vulnerable. *The BaMar section of Stony Point is/was receiving funding through the state for a buyout program (NY Rising Housing Recovery Program). The town is/was supporting NY Rising's Manufactured Home Community Resiliency Program (the Program) to assist all eligible households residing in BaMar and owners of mobile/manufactured homes in BaMar who choose to move out of the community. Eligible applicants had/have the option to participate in one of the three new home options offered by the program.*
  - No natural hazard ordinance. No post disaster recovery ordinance. No sensitive areas or steep slopes regulations. *It does not appear these projects have been undertaken.*
  - Review existing local codes and ordinances against the identified hazards to determine whether there needs to be any amendments to address identified hazards and, where a need is identified; modify/amend the codes/ordinances as applicable. This is a high priority. See Recommendations 2, 8, 10, and 17 from the Report on Coastal Vulnerability and Sea Level Rise. *Some ordinance revisions have been implemented since 2014.*
  - Update LWRP and ensure that it addresses sea level rise and coastal storms. Mitigation Action/Project Number SP-8. *It does not appear this project has been undertaken.*
  - Update the Town Code by reviewing existing local codes and ordinances to determine whether there are any amendments needed to address hazards and modify/amend as applicable. Mitigation Action/Project Number SP-3. *It does not appear this project has been undertaken.*

- *Rockland Tomorrow: County Comprehensive Plan:* 2011
  Specific elements detailed in the plan specific to the Town of Stony Point include the following:
  - Land Use and Zoning Chapter
    - Key issues identified include what will happen with vacant industrial sites on or near the Hudson Riverfront and vacant commercial sites in the Town's retail corridor. *Some ordinance revisions have taken place, but it is not clear if the desired changes have been implemented since 2011.*
  - Floodplains – High flood risk- large flood zones along Hudson River.

6.2.2 TOWN OF HAVERSTRAW

Zoning & Other Code(s) Analysis

https://ecode360.com/11795031

The town has a "Flood Damage Prevention" code (Chapter 87) detailing regulations related to minimizing damage related to flooding, a Freshwater Wetlands code (Chapter 90) which states that Article 24 of the

Environmental Conservation Law is incorporated by reference into the Town Code, and a Stormwater Management code (Part 3, Article XVI).

Section 167-36, multifamily housing in the WRD District, has provisions to exclude water bodies from the buildable lot area. Additionally, the first-floor elevation for all buildings and parking areas shall be above the limits of the floodplain (adjusted for wave action – no less than 2 feet above the 100-year floodplain). Regarding minimum lot area, no more than 50 percent of any lot may include lands underwater or within the 100-year floodplain. Section 167-65, Floodplain Buffer, has a 15-foot buffer requirement adjacent to the 100-year floodplain.

Other Land Use Documents Reviewed:

The Town of Haverstraw did not have any readily publicly available municipal planning documents for review.

- *Rockland County Multi-Jurisdictional Natural Hazard Mitigation Plan Update* 2018
    - *There were no land use planning or zoning-related recommendations.*

- *Rockland Tomorrow: County Comprehensive Plan* 2011

  Specific elements detailed in the plan specific to the Town of Stony Point include the following:
    - Land Use and Zoning Chapter
        - Key issues identified: The riverfront presents significant opportunities for Haverstraw's revitalization, especially with the existence of the Haverstraw-Ossining ferry service. Constraining issues in the town include the ongoing presence of waterfront industry, which while important to the town's economic development strategy can affect future redevelopment of the waterfront and impede public access to the Hudson River, and the challenge of providing ways to safely connect isolated commercial and multifamily housing uses.
    - Floodplains – High flood risk- large flood zones along Hudson River

6.2.3 VILLAGE OF WEST HAVERSTRAW

Zoning & Other Code(s) Analysis

https://ecode360.com/5092559

The village has a "Flood Damage Prevention" code (Chapter 112) that was adopted in 2014. This section includes standards related to elevation and flood-resistant construction. The village also has “Stormwater Management” regulations (Chapter 202).

Other Land Use Documents Reviewed:

The village is located within the town of Haverstraw. The village of West Haverstraw did not have any readily publicly available municipal planning documents for review.

- *Rockland County Multi-Jurisdictional Natural Hazard Mitigation Plan Update* 2018

- Update the comprehensive plan to incorporate natural disaster mitigation techniques. This is a high priority initiative. Recommendation VWH-2. *There were no publicly available documents created since 2018 to review related to this recommendation; however, the village adopted a Flood Damage Prevention Ordinance in 2014*.

6.2.4 VILLAGE OF POMONA

Zoning & Other Code(s) Analysis

https://ecode360.com/12718574

The village has a "Flood Damage Prevention" code (Chapter 79) adopted in 2014. This chapter has standards related to elevation and flood-resistant construction. The village also has a "Wetlands" code (Chapter 126) and "Stormwater Management" code (Chapter 114).

In addition, the tree permit removal process requires a plan showing wetland and floodplain areas (Section 121-5). Chapter 119, Site Development Plan Review, states "that the proposed activity and the manner in which it is to be accomplished will not adversely affect the preservation and protection of existing wetlands, water bodies, watercourses and floodplains."

The subdivision regulations in Section 118-25 state that no more than 25 percent of the minimum lot area can be under water or be defined as a wetland.

Section 130-10, Special Permit uses, has a minimum net lot area calculation and states that no portion of any land under water counts toward the net lot area, and no more than ¼ of the lot that is a wetland or within the 100-year floodplain can be counted toward the net lot area.

Other Land Use Documents Reviewed:

The Village of Pomona did not have any readily publicly available municipal planning documents for review. It is located partly in the town of Haverstraw and partly in the town of Ramapo.

- *Rockland County Multi-Jurisdictional Natural Hazard Mitigation Plan Update* 2018
    - Ensure that local comprehensive plans incorporate natural disaster mitigation techniques. This is a high priority Initiative (VP-1). *There were no publicly available documents created since 2018 to review related to this recommendation; however, the village adopted a Flood Damage Prevention Ordinance in 2014 and has requirements in other sections of the code*.

6.2.5 TOWN OF RAMAPO

Zoning & Other Code(s) Analysis

https://ecode360.com/11858832

The town has a "Flood Damage Prevention" code (Chapter 149). The code has standards related to elevation and flood-resistant construction. The Town also has a “Stormwater Management and Sediment and Erosion Control” code (Chapter 237) and a “Streams and Watercourses” code (Chapter 240), which regulates certain acts that are permitted or prohibited within a stream or watercourse. Section 376-42 of the Zoning Ordinance requires that not more than 50 percent of a lot be land underwater or land in the 100-year floodplain.

Other Land Use Documents Reviewed:

The Town of Ramapo has a number of plans that are relevant to this flood study, in addition to the Rockland County Hazard Mitigation Plan, which are summarized below.

- *Rockland County Multi-Jurisdictional Natural Hazard Mitigation Plan Update* 2018
  - Integrate hazard mitigation and hazard areas into the Comprehensive Plan. Action 1B.
  - Hold periodic workshops regarding zoning and planning issues that arise regarding natural hazards and hazard mitigation. Action 4.
  - Review and update existing local codes/ordinances against the identified hazards to determine whether there needs to be any amendments to address identified hazards and, where a need is identified; modify/amend the codes/ordinances as applicable. Action 12.

  There were no publicly available documents created since 2018 to review related to this recommendation; however, the town adopted a Flood Damage Prevention Ordinance in 2014, and the code has standards regarding lot coverage for floodplains and areas under water.
- *Town of Ramapo Comprehensive Plan 2004*
  - Environment Chapter – Areas subject to periodic flooding include properties along the Mahwah River and the Pascack Brook.
  - Assess whether or not to enact a wetlands law to provide an additional level of protection for wetlands. *Wetlands are a defined term in the Stormwater Control regulations, but there do not appear to be stand-alone wetlands regulations.*
  - Assess whether or not to require vegetation buffer zones along watercourses. *Buffers are a defined term in the code, and buffers are related to required yards, but there do not to appear to be requirements for vegetated buffer zones along watercourses.*
  - Consider reducing the permitted development intensity by:
    - Require that the area of the lot without the specified impediments be a contiguous area and in a location on the lot that makes development on it feasible in light of other considerations.
    - Increase the percentage of the lot that must be free of the specified impediments from 50 percent to a higher percentage (e.g., 75 percent).
    - Require that wetland areas be deducted from minimum lot area requirements.
    - Consider decreasing the percentage of such areas that may be counted toward meeting the lot area requirement from 50 percent to a lower percentage (e.g., 25 percent).

- ➢ Apply these provisions to lots intended for nonresidential use – the first sentence of Section 376-42.A states that these provisions apply only to minimum lot area requirements for residential uses.

Some code changes that relate to these topics have been implemented since the 2004 Comprehensive Plan.

- For Subdivision regulations, consider the following revisions:
  - ➢ Identify any standards that are inconsistent with the objective of minimizing overall land disturbance during subdivision development. Examples include reducing roadway widths, required cul-de-sac dimensions, etc. to reduce the amount of land disturbance and impervious surface.
- The Town of Ramapo should protect rivers and streams, including their riparian buffers, banks, and floodplains. Preference should be given to the following:
  - ➢ Properties within the 100-year floodplain of rivers and streams
  - ➢ Properties adjacent to the water bodies identified as stressed, threatened, impaired, or precluded on the New York State Department of Environmental Conservation Priority Water Body List
  - ➢ Properties adjacent to Class A (a water body classified by the NYSDEC as suitable for swimming) rivers or streams, or rivers and streams which support fish
  - ➢ Riparian buffers (an area of trees, shrubs, and herbaceous vegetation located adjacent to and upslope from a lake, stream, or other body of water which maintains stream system integrity, protects water quality, and improves the habitat of plants and animals on land and in the water) along stream or river corridors
  - ➢ Properties that surround or adjoin springs or intermittent streams
- The town should protect its watershed. Preference should be given to:
  - ➢ …Wetlands, floodplains, and riparian buffers.
- For Housing…
  - ➢ Properties to be considered for multifamily rezoning should be unencumbered by environmental resources such as steep slopes, wetlands, streams, floodplains, and other factors that would suggest that the property is not suitable for the intensity of development proposed.

A Northeast Ramapo Strategic Plan is/was under development. The Generic Environmental Impact Statement/State Environmental Quality Review Act (GEIS/SEQRA) forms are online, but the plan was not.

6.2.6 VILLAGE OF WESLEY HILLS

Zoning & Other Code(s) Analysis

https://ecode360.com/27842469

The village has a "Flood Damage Prevention" code (Chapter 119). The code has standards related to elevation and flood-resistant construction. There are requirements in the special permit uses for schools that limit wetlands and the 100-year floodplain to no more than ¼ of the minimum lot area (Section 230-26).

Table of Dimensional Requirements

Not more than 25% of any land under water, within a one-hundred-year frequency floodplain, within utility easements or other easements or rights-of-way, or with unexcavated slopes over 25% shall be counted toward the minimum lot area.
The Village Wetlands Code (Chapter 221) defines wetlands as all lands and waters designated on the State Wetlands Map, which have a contiguous area of at least 1/10 of an acre and which contain other elements such as submerged lands, wetland vegetation, etc.

The Village Stormwater Management Code (Chapter 181) was established to create minimum stormwater management requirements and controls to protect and safeguard the community by meeting certain objectives.

Other Land Use Documents Reviewed:

The Village of Wesley Hills did not have any readily publicly available municipal planning documents for review.

6.2.7 VILLAGE OF NEW HEMPSTEAD

Zoning & Other Code(s) Analysis

https://ecode360.com/30180572

The village has a "Flood Damage Prevention" code (Chapter 154). The code has standards related to elevation and flood-resistant construction. The village also has a "Freshwater Wetlands" code (Chapter 159) and Stormwater Management and Erosion and Sediment Control code (Chapter 245).

Village of New Hempstead Table of Dimensional Requirements includes the following standards:

No part of any land within an access easement or right-of-way shall be counted toward the minimum lot area. Only 25% of any land under water or within land defined as a wetland by Chapter 159, Freshwater Wetlands, of the Code of the Village of New Hempstead or within a one-hundred-year-frequency floodplain or within a drainage easement containing open drainage channels or facilities or within a utility easement containing overhead lines or equipment or with unexcavated slopes over 25% shall be counted toward the minimum lot area. Only 75% of any land within a conservation easement or within a drainage easement containing only piped drainage facilities or within a sewer easement or utility easement containing only underground facilities shall be counted toward the minimum lot area. The rules set forth herein shall apply with equal effect to preexisting and proposed easements and rights-of-way.

Other Land Use Documents Reviewed:

- *Village of New Hempstead Comprehensive Plan – 2020*
  - The Village Comprehensive Plan is a policy document focused on nine basic land use planning-focused principles. None of the principles specifically lists flooding.
  - There are four areas within the 100-year floodplain and one location within the 500-year floodplain. The Pascack Brook is identified as having some floodplain within the village though it was not detailed in the plan. The floodplain around the New York Country Club contains approximately 55 acres of Zone A Floodplain. The plan notes that such a use would seem ideal for an area within a floodplain; however, golf courses are not specifically exempted from the village's Flood Damage Prevention Law. There is Zone A floodplain around the South Branch of the Minisceongo Creek covering approximately 45 acres of land within the northern portion of the village. There are multiple properties within or partly within the floodplain, including residential structures. There is an approximately 6.5-acre floodplain near Ashlawn Court with at least one dwelling located within the floodplain. The plan recommended that the village "promote" setbacks from a stream and elevation above the BFE for new development and additions.
  - The plan notes that the village is working with others to form a Stormwater Consortium which could, among other objectives, "…attenuate flood risk." *The status of this consortium should be confirmed as this is a positive step toward coordinated efforts that cross municipal boundaries*.
  - Quality Neighborhoods Goal #9 is to "Promote stormwater quality and ensure there is not increased potential flooding from land use layouts which enable rapid flows off-site…"

6.3 BEST PRACTICES RECOMMENDATIONS

As a component of this flood analysis, a Flood Resiliency Best Practices Audit was conducted for each watershed community. A map with the boundaries of the Minisceongo Creek watershed and the towns and villages that fall within it is depicted in Figure 3-1. Results of the audit are presented in the following tables:

Table 6-1: Town of Stony Point
Table 6-2: Town of Haverstraw
Table 6-3: Village of West Haverstraw
Table 6-4: Village of Pomona
Table 6-5: Town of Ramapo
Table 6-6: Village of Wesley Hills
Table 6-7: Village of New Hempstead

6.3.1 ELEVATION DESIGN AND SCREENING BEST PRACTICES

Based on the preliminary analysis undertaken through the Flood Resiliency Best Practices Audit Checklist, no communities appeared to have specific elevation design and screening criteria in their zoning code for flood-elevated structures. All communities should consider assessing and revising their codes to incorporate specific elevation design and screening best practices. In addition, a Zoning Code requires that multifamily developments provide permanent access to the Hudson Riverfront. Any community with Hudson Riverfront should consider incorporating a similar requirement if it does not already exist.

6.3.2 BULK AND AREA REQUIREMENT FLEXIBILITY

All communities should consider assessing and revising bulk and area requirements to provide flexibility to allow modifications to setbacks, impervious coverage, and potentially even maximum heights to permit structures to be elevated above the BFE and still provide floor area possibilities that take into account a "loss" of ground floor habitable space. While modifications of such setbacks can be obtained through a Zoning Board of Appeals process and are sometimes waived by a Planning Board, specific regulations permitting deviations from the standard bulk and area requirements, subject to Planning Board approval and proven necessary through the appropriate data and documentation, could bring about more resilient, better designed, and less controversial developments.

6.3.3 FLOODPLAIN CONSTRUCTION PERMITTING

Some codes could benefit from tightening up the regulations permitting construction within a floodplain. Consideration of severely restricting or outright banning construction within significant riparian buffer areas and removing these areas from development could be considered. Areas that continually flood could be required to be removed from a density calculation. These areas should be assessed and likely mapped with the rationale for such a strict application. If a community is interested in identifying concepts or efforts to compensate landowners for the inability to now utilize these areas for development, likely by providing increased density or smaller lot sizes (thereby resulting in less infrastructure and site preparation cost) or purchase as public open space, that should also be considered.

6.3.4 SUBDIVISION REGULATIONS

Subdivision codes, where they exist, could use significant assessment for additional flood resiliency revisions. Since subdivisions can be the first step in larger land development applications, assessing potential regulatory changes in this part of the code could provide a significant resiliency benefit to address development-based flooding concerns. While the codes do generally require proposals to minimize flood-related damage and data for projects greater than a certain number of lots or acres when no BFE data is available, there are specific code regulations that could be enacted that provide specific protections and that could increase resiliency without taking away the potential to reasonably develop a property.

Table 6-1: Flood Resiliency Best Practices Code Audit Checklist				
Town of Stony Point, NY Preliminary Audit	*In Existing Code*	*Consider for Implementation*	*N/A*	*Notes*
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	☐	☐	☐	
Use hedges and fencing to separate private and public realms. Screen on-site parking located beneath a structure with foundation plantings and vegetative screening. Screen piers and columns that have been used to raise structures.	☐	☐	☐	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	☐	☐	☐	
Building fronts, entry porches and similar features must use materials, colors and proportions appropriate for the local architectural context. Large and multi-family building should use treatments similar to ensure local architectural consistency.	☐	☐	☐	
Guidelines for specific design elements such as canopies, galleries, and local significant materials, colors and design strategies to mitigate height and size perceptions are encouraged.	☐	☐	☐	
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	☑	☐	☐	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces.
Permit relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	☐	☐	☐	
Enact new height limits where possible that are based on the new local design flood elevation (one to two feet over the BFE) where side and rear yard relief is possible.	☐	☐	☐	
Given the increased height of buildings due to elevation, turrets, towers and cupolas, ensure total building height does not exceed maximum height(s) desired, but also ensure that maximum building height requirements allow for building elevations without the need for a variance.	☐	☐	☐	
Require an additional 3' of freeboard above the base flood elevation for buildings within the Special Flood Hazard Area and 18" of freeboard in the "shaded X" area, which includes buildings between the 100-year and 500-year floodplains. All new single family detached dwellings outside of defined flood hazard areas need to be elevated 16-24". This approach acknowledges the likelihood of more extreme flooding inside of and more extensive flooding outside of the FEMA-defined flood hazard area (based on historic flooding and not sea-level rise).	☑	☐	☐	The code includes residential and non-residential structure coastal high-hazard area construction standards. For residential structures, elevations of 2' and 3' above BFE in certain zones are required as well as requirements for drainage paths in other zones. For non-high hazard areas, the lowest floor should be elevated 2' above BFE. Structures are to be floodproofed so that the structure is watertight below two feet above the base flood elevation. Within a coastal high hazard area, the lowest floor is to be two feet above the BFE as well.
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	☐	☐	☐	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	☐	☐	☐	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	☐	☐	☐	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	☐	☐	☐	

Table 6-1: Flood Resiliency Best Practices Code Audit Checklist *Town of Stony Point, NY Preliminary Audit*	*In Existing Code*	*Consider for Implementation*	*N/A*	*Notes*
Other Code Revisions				
Coastal Resilience Overlays could be applied to areas with the highest flood risk. These areas require higher elevations of the first floor, limit parking and hard pavement, and require additional landscaping and open space.	☑	☐	☐	
Upland Resilience Overlays could be applied to lower-risk areas capable of accommodating growth. New construction within an Upland Resilience Overlay is also permitted to reduce its own resilience requirements in exchange for placing conservation easements on higher-risk properties.	☑	☐	☐	This exists in a way in the code. Within special flood hazard areas, construction or improvements are prohibited without a valid floodplain development permit. For encroachments, assessments and/or a technical evaluation is conducted and the Village applies to FEMA for conditional Firm and floodway revision and approval is received.
Neighborhood Resilience Overlays could be applied to lower-risk areas, and are intended for more typical cases. They allow for customized design standards that are appropriate to the local context.	☑	☐	☐	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	☐	☐	☐	
Ensure that well heads are above the BFE.	☑	☐	☐	The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system.
Add flood resistant construction (flood-proofing) standards such as ensuring buildings are watertight, utilities and sanitary facilities are above the BFE, enclosed within the building's watertight walls, or made watertight and resistance. Standards should also ensure that the building's structural components are also flood resistant.	☑	☐	☐	The Code requires anchoring of new structures and substantial improvements as well as the use of materials, utility equipment, and methods and practices that are resistant to flood damage and that minimize flood damage. Utilities must be at or above the BFE. Water supply systems must minimize or eliminate infiltration of floodwaters. On-site waste disposal systems must be located to avoid impairment to them, or contamination from them, during flood events.
Prohibit new development unless effect on flooding is minimal or zero.	☑	☐	☐	Code prohibits development encroachment if increases base flood by >1 foot (see encroachment note above). The code requires a details of any watercourse alteration or relocation. There are detailed permit application requirements including a technical analysis to determine whether or not proposed development will result in physical damage to any other property.
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	☐	☐	☐	
Consider acquisition of flood-prone lands, particularly where they include vital riparian areas and/or could provide a public benefit such as a park or passive open space.	☐	☐	☐	
Subdivision Ordinance Best Practices				
Subdivision Ordinance				
Conservation subdivision (cluster development) to encourage development be built in suitable areas of development that protects important natural features.	☑	☐	☐	There is a cluster provision in the code.
Prohibit subdivisions in floodprone areas.	☑	☐	☐	The Flood Damage Prevention Ordinance requires subdivisions to be consistent with the need to minimize flood damage, utilities and facilities must be located and constructed to minimize flood damage, and adequate drainage needs to be provided to reduce exposure to flood damage. For minimum lot area requirements, only a percentage of land underwater can be counted. When no based flood elevation data are available from other sources, the permit applicant for a subdivision or other development shall provide the data for projects greater than 5 acres or 50 lots.

Table 6-1: Flood Resiliency Best Practices Code Audit Checklist				
Town of Stony Point, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:	☑	☐	☐	The code includes a stream protection section with stream conservation buffer areas defined.
Stream stabilization - A few dozen feet to a few hundred feet.	☐	☐	☐	
Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)	☐	☐	☐	
Flood attenuation – A few dozen to several hundred feet	☐	☐	☐	
Riparian & wildlife habitat – A few dozen feet up to a mile, though the average minimum is approximately 100' to several hundred or a few thousand feet.	☐	☐	☐	
Protection of cold water fisheries – A few dozen feet to a few hundred feet	☐	☐	☐	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	☐	☐	☐	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	☐	☐	☐	
Require restoration of impaired riparian zones as a condition of subdivision approval.	☐	☐	☐	
Restrict potentially problematic uses (Hazardous materials uses, for example)	☐	☐	☐	
Dedicate land for public facilities and services.	☐	☐	☐	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	☐	☐	☐	
Ensure utilities such as electric, natural gas, water and wastewater are hardened. Require electrical components to be mounted above flood levels. Major utility equipment should be considered a critical facility and be required to be located outside of the 500 year floodplain.	☐	☐	☐	
Consider the long-term needs of the community when discussing the potential for a homeowner's association to operate and/or maintain an area prone to flooding.	☐	☐	☐	
Require flood hazard information to be provided on a subdivision plat. Require the 100-year floodplain elevation to be shown on all subdivision plats. Information such as finished building pad elevation or proposed lowest finished floor elevation can also be detailed.	☐	☐	☐	
Any property with a floodplain should be required to show such information on the plan.	☐	☐	☐	
Require conservation easements around flood-prone areas or floodplains.	☐	☐	☐	
Require green infrastructure or low-impact development techniques, where feasible	☑	☐	☐	The code includes Stormwater Pollution Prevention Plan (SWPPP) requirements. There are code requirements that only a percentage of land underwater count toward minimum lot area.
Each proposed lot must have a designated buildable site above the special flood hazard area (SFHA) as shown on the most current Flood Insurance Rate Map.	☐	☐	☐	

See Chapter 3 of this report for source information.

Code Sections Reviewed:

Flood Damage Prevention - Chapter 112

Subdivision of Land - Chapter 191

Stormwater Management - Chapter 185

Freshwater Wetlands - Chapter 116

Landscaping; Environmental Control; Swimming Pools; Floodplains - Article XI

Site Development Plan Rules and Regulations - Chapter A220

Bulk Table Special Requirements - §215-15

Table 6-2 Flood Resiliency Best Practices Code Audit Checklist *Town of Haverstraw, NY Preliminary Audit*	*In Existing Code*	*Consider for Implementation*	*N/A*	*Notes*
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	☐	☐	☐	
Use hedges and fencing to separate private and public realms. Screen on-site parking located beneath a structure with foundation plantings and vegetative screening. Screen piers and columns that have been used to raise structures.	☐	☐	☐	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	☐	☐	☐	
Building fronts, entry porches and similar features must use materials, colors and proportions appropriate for the local architectural context. Large and multi-family building should use treatments similar to ensure local architectural consistency.	☐	☐	☐	
Guidelines for specific design elements such as canopies, galleries, and local significant materials, colors and design strategies to mitigate height and size perceptions are encouraged.	☑	☐	☐	All multifamily housing developments in the WRD must provide permanent public access to the Hudson Riverfront.
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	☑	☐	☐	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces.
Permit relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	☐	☐	☐	
Enact new height limits where possible that are based on the new local design flood elevation (one to two feet over the BFE) where side and rear yard relief is possible.	☐	☐	☐	
Given the increased height of buildings due to elevation, turrets, towers and cupolas, ensure total building height does not exceed maximum height(s) desired, but also ensure that maximum building height requirements allow for building elevations without the need for a variance.	☐	☐	☐	
Require an additional 3' of freeboard above the base flood elevation for buildings within the Special Flood Hazard Area and 18" of freeboard in the "shaded X" area, which includes buildings between the 100-year and 500-year floodplains. All new single family detached dwellings outside of defined flood hazard areas need to be elevated 16-24". This approach acknowledges the likelihood of more extreme flooding inside of and more extensive flooding outside of the FEMA-defined flood hazard area (based on historic flooding and not sea-level rise).	☑	☐	☐	Standards are included that require between 2' and 3' above BFE in certain zones as well as requirements for drainage paths in other zones for residential structures. Multi-family housing in the WRD district has a 2' above floodplain limitation adjusted for wave action. For non-residential structures, the lowest floor should be elevated 2' above BFE if no FIRM number is specified. Structures are to be floodproofed so that the structure is watertight below two feet above the base flood elevation, including utilities and sanitary facilities. Within the A, when no base flood data are available, the lowest floor (including basement) shall be elevated at least 3' above the highest adjacent grade.
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	☐	☐	☐	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	☐	☐	☐	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	☐	☐	☐	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	☐	☐	☐	

Table 6-2 Flood Resiliency Best Practices Code Audit Checklist				
Town of Haverstraw, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Other Code Revisions				
Coastal Resilience Overlays could be applied to areas with the highest flood risk. These areas require higher elevations of the first floor, limit parking and hard pavement, and require additional landscaping and open space.	☑	☐	☐	
Upland Resilience Overlays could be applied to lower-risk areas capable of accommodating growth. New construction within an Upland Resilience Overlay is also permitted to reduce its own resilience requirements in exchange for placing conservation easements on higher-risk properties.	☑	☐	☐	This exists in a way in the code. Within special flood hazard areas, construction or improvements are prohibited without a valid floodplain development permit. For encroachments, assessments and/or a technical evaluation is conducted and the Village applies to FEMA for conditional Firm and floodway revision and approval is received.
Neighborhood Resilience Overlays could be applied to lower-risk areas, and are intended for more typical cases. They allow for customized design standards that are appropriate to the local context.	☑	☐	☐	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	☐	☐	☐	
Ensure that well heads are above the BFE.	☑	☐	☐	The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system.
Add flood resistant construction (flood-proofing) standards such as ensuring buildings are watertight, utilities and sanitary facilities are above the BFE, enclosed within the building's watertight walls, or made watertight and resistance. Standards should also ensure that the building's structural components are also flood resistant.	☑	☐	☐	The Code requires anchoring of new structures and substantial improvements as well as the use of materials, utility equipment, and methods and practices that are resistant to flood damage and that minimize flood damage. Utilities must be at least 2' above BFE. Water supply systems must minimize or eliminate infiltration of floodwaters. On-site waste disposal systems must be located to avoid impairment to them, or contamination from them, during flood events.
Prohibit new development unless effect on flooding is minimal or zero.	☑	☐	☐	Code prohibits development encroachment if increases base flood by >1 foot (see encroachment note above). The code requires a details of any watercourse alteration or relocation. There are detailed permit application requirements including a technical analysis to determine whether or not proposed development will result in physical damage to any other property. Waterbodies are excluded are excluded from buildable lot area calculations.
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	☐	☐	☐	
Consider acquisition of flood-prone lands, particularly where they include vital riparian areas and/or could provide a public benefit such as a park or passive open space.	☐	☐	☐	

Table 6-2 Flood Resiliency Best Practices Code Audit Checklist				
Town of Haverstraw, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Subdivision Ordinance Best Practices				
Subdivision Ordinance				
Conservation subdivision (cluster development) to encourage development be built in suitable areas of development that protects important natural features.	☑	☐	☐	The code states that the Planning Board can modify provisions to enable and encourage flexibility of design nd development of land in such a manner as to promote the most appropriate use of land.
Prohibit subdivisions in floodprone areas.	☑	☐	☐	The Flood Damage Prevention Ordinance requires subdivisions to be consistent with the need to minimize flood damage, utilities and facilities must be located and constructed to minimize flood damage, and adequate drainage needs to be provided to reduce exposure to flood damage. There are code requirements that only a percentage of land underwater count toward minimum lot area. When no based flood elevation data are available from other sources, the permit applicant for a subdivision or other development shall provide the data for projects greater than 2 acres or 5 lots.
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:	☐	☐	☐	
Stream stabilization - A few dozen feet to a few hundred feet.	☐	☐	☐	
Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)	☐	☐	☐	
Flood attenuation – A few dozen to several hundred feet	☐	☐	☐	
Riparian & wildlife habitat – A few dozen feet up to a mile, though the average minimum is approximately 100' to several hundred or a few thousand feet.	☐	☐	☐	
Protection of cold water fisheries – A few dozen feet to a few hundred feet	☐	☐	☐	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	☐	☐	☐	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	☐	☐	☐	
Require restoration of impaired riparian zones as a condition of subdivision approval.	☐	☐	☐	
Restrict potentially problematic uses (Hazardous materials uses, for example)	☐	☐	☐	
Dedicate land for public facilities and services.	☐	☐	☐	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	☐	☐	☐	
Ensure utilities such as electric, natural gas, water and wastewater are hardened. Require electrical components to be mounted above flood levels. Major utility equipment should be considered a critical facility and be required to be located outside of the 500 year floodplain.	☐	☐	☐	
Consider the long-term needs of the community when discussing the potential for a homeowner's association to operate and/or maintain an area prone to flooding.	☐	☐	☐	
Require flood hazard information to be provided on a subdivision plat. Require the 100-year floodplain elevation to be shown on all subdivision plats. Information such as finished building pad elevation or proposed lowest finished floor elevation can also be detailed.	☐	☐	☐	
Any property with a floodplain should be required to show such information on the plan.	☐	☐	☐	
Require conservation easements around flood-prone areas or floodplains.	☐	☐	☐	

Table 6-2 Flood Resiliency Best Practices Code Audit Checklist				
Town of Haverstraw, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Require green infrastructure or low-impact development techniques, where feasible	☑	☐	☐	The code includes Stormwater Pollution Prevention Plan (SWPPP) requirements.
Each proposed lot must have a designated buildable site above the special flood hazard area (SFHA) as shown on the most current Flood Insurance Rate Map.	☐	☐	☐	

See Chapter 3 of this report for source information.

<u>Code Sections Reviewed:</u>

Flood Damage Prevention - Chapter 87

Subdivision of Land - Chapter A176

Stormwater Management - Part 3

Freshwater Wetlands - Chapter 90

Special Permit Uses (Multifamily in WRD) - Article 5

Table 6-3: Flood Resiliency Best Practices Code Audit Checklist				
Village of West Haverstraw, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	☐	☐	☐	
Use hedges and fencing to separate private and public realms. Screen on-site parking located beneath a structure with foundation plantings and vegetative screening. Screen piers and columns that have been used to raise structures.	☐	☐	☐	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	☐	☐	☐	
Building fronts, entry porches and similar features must use materials, colors and proportions appropriate for the local architectural context. Large and multi-family building should use treatments similar to ensure local architectural consistency.	☐	☐	☐	
Guidelines for specific design elements such as canopies, galleries, and local significant materials, colors and design strategies to mitigate height and size perceptions are encouraged.	☑	☐	☐	The code includes general design standards which discuss land subdivision being used safely without danger from flood, but no specific standards are found within the Design Standards section.
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	☑	☐	☐	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces.
Permit relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	☐	☐	☐	
Enact new height limits where possible that are based on the new local design flood elevation (one to two feet over the BFE) where side and rear yard relief is possible.	☐	☐	☐	
Given the increased height of buildings due to elevation, turrets, towers and cupolas, ensure total building height does not exceed maximum height(s) desired, but also ensure that maximum building height requirements allow for building elevations without the need for a variance.	☐	☐	☐	
Require an additional 3' of freeboard above the base flood elevation for buildings within the Special Flood Hazard Area and 18" of freeboard in the "shaded X" area, which includes buildings between the 100-year and 500-year floodplains. All new single family detached dwellings outside of defined flood hazard areas need to be elevated 16-24". This approach acknowledges the likelihood of more extreme flooding inside of and more extensive flooding outside of the FEMA-defined flood hazard area (based on historic flooding and not sea-level rise).	☑	☐	☐	The code includes residential and non-residential structure coastal high-hazard area construction standards. Standards are included that require between 2' and 3' above BFE in certain zones as well as requirements for drainage paths in other zones for residential structures. For non-high hazard areas, the lowest floor should be elevated 2' above BFE.
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	☐	☐	☐	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	☐	☐	☐	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	☐	☐	☐	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	☐	☐	☐	

Table 6-3: Flood Resiliency Best Practices Code Audit Checklist				
Village of West Haverstraw, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Other Code Revisions				
Coastal Resilience Overlays could be applied to areas with the highest flood risk. These areas require higher elevations of the first floor, limit parking and hard pavement, and require additional landscaping and open space.	☑	☐	☐	
Upland Resilience Overlays could be applied to lower-risk areas capable of accommodating growth. New construction within an Upland Resilience Overlay is also permitted to reduce its own resilience requirements in exchange for placing conservation easements on higher-risk properties.	☑	☐	☐	This exists in a way in the code. Within special flood hazard areas, construction or improvements are prohibited without a valid floodplain development permit. For encroachments, assessments and/or a technical evaluation is conducted and the Village applies to FEMA for conditional Firm and floodway revision and approval is received.
Neighborhood Resilience Overlays could be applied to lower-risk areas, and are intended for more typical cases. They allow for customized design standards that are appropriate to the local context.	☑	☐	☐	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	☐	☐	☐	
Ensure that well heads are above the BFE.	☑	☐	☐	The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system.
Add flood resistant construction (flood-proofing) standards such as ensuring buildings are watertight, utilities and sanitary facilities are above the BFE, enclosed within the building's watertight walls, or made watertight and resistance. Standards should also ensure that the building's structural components are also flood resistant.	☑	☐	☐	The Code requires anchoring of new structures and substantial improvements as well as the use of materials, utility equipment, and methods and practices that are resistant to flood damage and that minimize flood damage. Utilities must be at least 2' above BFE. Water supply systems must minimize or eliminate infiltration of floodwaters. On-site waste disposal systems must be located to avoid impairment to them, or contamination from them, during flood events.
Prohibit new development unless effect on flooding is minimal or zero.	☑	☐	☐	Code prohibits development encroachment if increases base flood by >1 foot (see encroachment note above). The code requires a details of any watercourse alteration or relocation. There are detailed permit application requirements including a technical analysis to determine whether or not proposed development will result in physical damage to any other property. Waterbodies are excluded are excluded from buildable lot area calculations.
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	☐	☐	☐	
Consider acquisition of flood-prone lands, particularly where they include vital riparian areas and/or could provide a public benefit such as a park or passive open space.	☐	☐	☐	

Table 6-3: Flood Resiliency Best Practices Code Audit Checklist ***Village of West Haverstraw, NY Preliminary Audit***	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Subdivision Ordinance Best Practices				
Subdivision Ordinance				
Conservation subdivision (cluster development) to encourage development be built in suitable areas of development that protects important natural features.	☑	☐	☐	
Prohibit subdivisions in floodprone areas.	☑	☐	☐	The Flood Damage Prevention Ordinance requires subdivisions to be consistent with the need to minimize flood damage, utilities and facilities must be located and constructed to minimize flood damage, and adequate drainage needs to be provided to reduce exposure to flood damage. The code Design Standards state that no area of the lot required under zoning provisions may be satisfied by land that is under water. When no based flood elevation data are available from other sources, the permit applicant for a subdivision or other development shall provide the data for projects greater than 5 acres or 50 lots.
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:	☐	☐	☐	
Stream stabilization - A few dozen feet to a few hundred feet.	☐	☐	☐	
Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)	☐	☐	☐	
Flood attenuation – A few dozen to several hundred feet	☐	☐	☐	
Riparian & wildlife habitat – A few dozen feet up to a mile, though the average minimum is approximately 100' to several hundred or a few thousand feet.	☐	☐	☐	
Protection of cold water fisheries – A few dozen feet to a few hundred feet	☐	☐	☐	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	☐	☐	☐	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	☐	☐	☐	
Require restoration of impaired riparian zones as a condition of subdivision approval.	☐	☐	☐	
Restrict potentially problematic uses (Hazardous materials uses, for example)	☐	☐	☐	
Dedicate land for public facilities and services.	☐	☐	☐	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	☐	☐	☐	
Ensure utilities such as electric, natural gas, water and wastewater are hardened. Require electrical components to be mounted above flood levels. Major utility equipment should be considered a critical facility and be required to be located outside of the 500 year floodplain.	☐	☐	☐	
Consider the long-term needs of the community when discussing the potential for a homeowner's association to operate and/or maintain an area prone to flooding.	☐	☐	☐	

Table 6-3: Flood Resiliency Best Practices Code Audit Checklist				
Village of West Haverstraw, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Require flood hazard information to be provided on a subdivision plat. Require the 100-year floodplain elevation to be shown on all subdivision plats. Information such as finished building pad elevation or proposed lowest finished floor elevation can also be detailed.	☐	☐	☐	
Any property with a floodplain should be required to show such information on the plan.	☐	☐	☐	
Require conservation easements around flood-prone areas or floodplains.	☐	☐	☐	
Require green infrastructure or low-impact development techniques, where feasible	☑	☐	☐	The code includes Stormwater Pollution Prevention Plan (SWPPP) requirements.
Each proposed lot must have a designated buildable site above the special flood hazard area (SFHA) as shown on the most current Flood Insurance Rate Map.	☐	☐	☐	

See Chapter 3 of this report for source information.

Code Sections Reviewed:

Flood Damage Prevention - Chapter 112

Subdivision of Land - Chapter 250, Article XVII

Stormwater Management - Chapter 202

Design Standards - Article XIX

Table 6-4 Flood Resiliency Best Practices Code Audit Checklist				
Village of Pomona, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	☐	☐	☐	
Use hedges and fencing to separate private and public realms. Screen on-site parking located beneath a structure with foundation plantings and vegetative screening. Screen piers and columns that have been used to raise structures.	☐	☐	☐	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	☐	☐	☐	
Building fronts, entry porches and similar features must use materials, colors and proportions appropriate for the local architectural context. Large and multi-family building should use treatments similar to ensure local architectural consistency.	☐	☐	☐	
Guidelines for specific design elements such as canopies, galleries, and local significant materials, colors and design strategies to mitigate height and size perceptions are encouraged.	☐	☐	☐	
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	☑	☐	☐	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces.
Permit relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	☐	☐	☐	
Enact new height limits where possible that are based on the new local design flood elevation (one to two feet over the BFE) where side and rear yard relief is possible.	☐	☐	☐	
Given the increased height of buildings due to elevation, turrets, towers and cupolas, ensure total building height does not exceed maximum height(s) desired, but also ensure that maximum building height requirements allow for building elevations without the need for a variance.	☐	☐	☐	
Require an additional 3' of freeboard above the base flood elevation for buildings within the Special Flood Hazard Area and 18" of freeboard in the "shaded X" area, which includes buildings between the 100-year and 500-year floodplains. All new single family detached dwellings outside of defined flood hazard areas need to be elevated 16-24". This approach acknowledges the likelihood of more extreme flooding inside of and more extensive flooding outside of the FEMA-defined flood hazard area (based on historic flooding and not sea-level rise).	☑	☐	☐	Standards are included that require between 2' and 3' above BFE in certain zones as well as requirements for drainage paths in other zones for residential structures. For non-residential structures, the lowest floor should be elevated 2' above BFE if no FIRM number is specified. Structures are to be floodproofed so that the structure is watertight below two feet above the base flood elevation, including utilities and sanitary facilities. Within the A, when no base flood data are available, the lowest floor (including basement) shall be elevated at least 3' above the highest adjacent grade.
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	☐	☐	☐	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	☐	☐	☐	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	☐	☐	☐	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	☐	☐	☐	

Table 6-4 Flood Resiliency Best Practices Code Audit Checklist

Village of Pomona, NY Preliminary Audit	*In Existing Code*	*Consider for Implementation*	*N/A*	*Notes*
Other Code Revisions				
Coastal Resilience Overlays could be applied to areas with the highest flood risk. These areas require higher elevations of the first floor, limit parking and hard pavement, and require additional landscaping and open space.	☑	☐	☐	
Upland Resilience Overlays could be applied to lower-risk areas capable of accommodating growth. New construction within an Upland Resilience Overlay is also permitted to reduce its own resilience requirements in exchange for placing conservation easements on higher-risk properties.	☑	☐	☐	This exists in a way in the code. Within special flood hazard areas, construction or improvements are prohibited without a valid floodplain development permit. For encroachments, assessments and/or a technical evaluation is required and when the Village agrees to apply to FEMA for conditional Firm and floodway revision and approval is received, only then can construction or substantial improvements move forward.
Neighborhood Resilience Overlays could be applied to lower-risk areas, and are intended for more typical cases. They allow for customized design standards that are appropriate to the local context.	☑	☐	☐	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	☐	☐	☐	
Ensure that well heads are above the BFE.	☑	☐	☐	The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system.
Add flood resistant construction (flood-proofing) standards such as ensuring buildings are watertight, utilities and sanitary facilities are above the BFE, enclosed within the building's watertight walls, or made watertight and resistance. Standards should also ensure that the building's structural components are also flood resistant.	☑	☐	☐	The Code requires anchoring of new structures and substantial improvements as well as the use of materials, utility equipment, and methods and practices that are resistant to flood damage and that minimize flood damage. Utilities must be at least 2' above BFE. Water supply systems must minimize or eliminate infiltration of floodwaters. On-site waste disposal systems must be located to avoid impairment to them, or contamination from them, during flood events.
Prohibit new development unless effect on flooding is minimal or zero.	☑	☐	☐	Code prohibits development encroachment if increases base flood by >1 foot (see encroachment note above). The code requires a details of any watercourse alteration or relocation. Furthermore, whenever any portion of a floodplain is authorized for development, the volume of space occupied by the authorized fill or structure below the base flood elevation shall be compensated for and balanced by a hydraulically equivalent volume of excavation taken from below the base flood elevation at or adjacent to the development site. All such excavations shall be constructed to drain freely to the watercourse. No area below the waterline of a pond or other body of water can be credited as a compensating excavation. There are detailed permit application requirements including a technical analysis to determine whether or not proposed development will result in physical damage to any other property.
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	☐	☐	☐	
Consider acquisition of flood-prone lands, particularly where they include vital riparian areas and/or could provide a public benefit such as a park or passive open space.	☐	☐	☐	

Table 6-4 Flood Resiliency Best Practices Code Audit Checklist				
Village of Pomona, NY Preliminary Audit	*In Existing Code*	*Consider for Implementation*	*N/A*	*Notes*
Subdivision Ordinance Best Practices				
Subdivision Ordinance				
Conservation subdivision (cluster development) to encourage development be built in suitable areas of development that protects important natural features.	☐	☐	☐	
Prohibit subdivisions in floodprone areas.	☑	☐	☐	The Flood Damage Prevention Ordinance requires subdivisions to be consistent with the need to minimize flood damage, utilities and facilities must be located and constructed to minimize flood damage, and adequate drainage needs to be provided to reduce exposure to flood damage. There are code requirements that a lot not contain more than certain percentage of floodplain. When no based flood elevation data are available from other sources, the permit applicant for a subdivision or other development shall provide the data for projects greater than 5 acres or 50 lots.
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:	☐	☐	☐	
Stream stabilization - A few dozen feet to a few hundred feet.	☐	☐	☐	
Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)	☐	☐	☐	
Flood attenuation – A few dozen to several hundred feet	☐	☐	☐	
Riparian & wildlife habitat – A few dozen feet up to a mile, though the average minimum is approximately 100' to several hundred or a few thousand feet.	☐	☐	☐	
Protection of cold water fisheries – A few dozen feet to a few hundred feet	☐	☐	☐	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	☐	☐	☐	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	☐	☐	☐	
Require restoration of impaired riparian zones as a condition of subdivision approval.	☐	☐	☐	
Restrict potentially problematic uses (Hazardous materials uses, for example)	☐	☐	☐	
Dedicate land for public facilities and services.	☐	☐	☐	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	☐	☐	☐	
Ensure utilities such as electric, natural gas, water and wastewater are hardened. Require electrical components to be mounted above flood levels. Major utility equipment should be considered a critical facility and be required to be located outside of the 500 year floodplain.	☐	☐	☐	
Consider the long-term needs of the community when discussing the potential for a homeowner's association to operate and/or maintain an area prone to flooding.	☐	☐	☐	
Require flood hazard information to be provided on a subdivision plat. Require the 100-year floodplain elevation to be shown on all subdivision plats. Information such as finished building pad elevation or proposed lowest finished floor elevation can also be detailed.	☐	☐	☐	
Any property with a floodplain should be required to show such information on the plan.	☐	☐	☐	
Require conservation easements around flood-prone areas or floodplains.	☐	☐	☐	

Table 6-4 Flood Resiliency Best Practices Code Audit Checklist Village of Pomona, NY Preliminary Audit	In Existing Code	Consider for Implementation	N/A	Notes
Require green infrastructure or low-impact development techniques, where feasible	☑	☐	☐	The code includes Stormwater Pollution Prevention Plan (SWPPP) requirements.
Each proposed lot must have a designated buildable site above the special flood hazard area (SFHA) as shown on the most current Flood Insurance Rate Map.	☐	☐	☐	

See Chapter 3 of this report for source information.

<u>Code Sections Reviewed:</u>

Flood Damage Prevention - Chapter 79

Subdivision of Land - Chapter 118

Stormwater Management - Chapter 114

Wetlands - Chapter 126

Table 6-5 Flood Resiliency Best Practices Code Audit Checklist				
Town of Ramapo Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	☐	☐	☐	
Use hedges and fencing to separate private and public realms. Screen on-site parking located beneath a structure with foundation plantings and vegetative screening. Screen piers and columns that have been used to raise structures.	☐	☐	☐	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	☐	☐	☐	
Building fronts, entry porches and similar features must use materials, colors and proportions appropriate for the local architectural context. Large and multi-family building should use treatments similar to ensure local architectural consistency.	☐	☐	☐	
Guidelines for specific design elements such as canopies, galleries, and local significant materials, colors and design strategies to mitigate height and size perceptions are encouraged.	☐	☐	☐	
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	☑	☐	☐	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces.
Permit relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	☐	☐	☐	
Enact new height limits where possible that are based on the new local design flood elevation (one to two feet over the BFE) where side and rear yard relief is possible.	☐	☐	☐	
Given the increased height of buildings due to elevation, turrets, towers and cupolas, ensure total building height does not exceed maximum height(s) desired, but also ensure that maximum building height requirements allow for building elevations without the need for a variance.	☐	☐	☐	
Require an additional 3’ of freeboard above the base flood elevation for buildings within the Special Flood Hazard Area and 18” of freeboard in the “shaded X” area, which includes buildings between the 100-year and 500-year floodplains. All new single family detached dwellings outside of defined flood hazard areas need to be elevated 16-24”. This approach acknowledges the likelihood of more extreme flooding inside of and more extensive flooding outside of the FEMA-defined flood hazard area (based on historic flooding and not sea-level rise).	☑	☐	☐	Standards are included that require between 2' and 3' above BFE in certain zones as well as requirements for drainage paths in other zones for residential structures. For non-residential structures, the lowest floor should be elevated 2' above BFE if no FIRM number is specified. Structures are to be floodproofed so that the structure is watertight below two feet above the base flood elevation, including utilities and sanitary facilities. Within the A, when no base flood data are available, the lowest floor (including basement) shall be elevated at least 3' above the highest adjacent grade.
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	☐	☐	☐	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	☐	☐	☐	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	☐	☐	☐	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	☐	☐	☐	

Table 6-5 Flood Resiliency Best Practices Code Audit Checklist

Town of Ramapo Preliminary Audit	In Existing Code	Consider for Implementation	N/A	Notes
Other Code Revisions				
Coastal Resilience Overlays could be applied to areas with the highest flood risk. These areas require higher elevations of the first floor, limit parking and hard pavement, and require additional landscaping and open space.	☑	☐	☐	
Upland Resilience Overlays could be applied to lower-risk areas capable of accommodating growth. New construction within an Upland Resilience Overlay is also permitted to reduce its own resilience requirements in exchange for placing conservation easements on higher-risk properties.	☑	☐	☐	This exists in a way in the code. Regulations are subject to specific FIRM maps detailed in the code. This exists in a way in the code. Within special flood hazard areas, construction or improvements are prohibited without a valid floodplain development permit. For encroachments, assessments and/or a technical evaluation is required and when the Village agrees to apply to FEMA for conditional Firm and floodway revision and approval is received, only then can construction or substantial improvements move forward.
Neighborhood Resilience Overlays could be applied to lower-risk areas, and are intended for more typical cases. They allow for customized design standards that are appropriate to the local context.	☑	☐	☐	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	☐	☐	☐	
Ensure that well heads are above the BFE.	☑	☐	☐	The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system.
Add flood resistant construction (flood-proofing) standards such as ensuring buildings are watertight, utilities and sanitary facilities are above the BFE, enclosed within the building's watertight walls, or made watertight and resistance. Standards should also ensure that the building's structural components are also flood resistant.	☑	☐	☐	The Code requires anchoring of new structures and substantial improvements as well as the use of materials, utility equipment, and methods and practices that are resistant to flood damage and that minimize flood damage. Utilities must be at least 2' above BFE. Water supply systems must minimize or eliminate infiltration of floodwaters. On-site waste disposal systems must be located to avoid impairment to them, or contamination from them, during flood events.
Prohibit new development unless effect on flooding is minimal or zero.	☑	☐	☐	Code prohibits development encroachment if increases base flood by >1 foot (see encroachment note above). The code requires a details of any watercourse alteration or relocation. There are detailed permit application requirements including a technical analysis to determine whether or not proposed development will result in physical damage to any other property.
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	☐	☐	☐	
Consider acquisition of flood-prone lands, particularly where they include vital riparian areas and/or could provide a public benefit such as a park or passive open space.	☐	☐	☐	
Subdivision Ordinance Best Practices				
Subdivision Ordinance				
Conservation subdivision (cluster development) to encourage development be built in suitable areas of development that protects important natural features.	☐	☐	☐	There is a cluster provision in the code.
Prohibit subdivisions in floodprone areas.	☑	☐	☐	The Flood Damage Prevention Ordinance requires subdivisions to be consistent with the need to minimize flood damage, utilities and facilities must be located and constructed to minimize flood damage, and adequate drainage needs to be provided to reduce exposure to flood damage. There are code requirements that only a percentage of land underwater count toward minimum lot area. When no based flood elevation data are available from other sources, the permit applicant for a subdivision or other development shall provide the data for projects greater than 5 acres or 50 lots.

Table 6-5 Flood Resiliency Best Practices Code Audit Checklist				
Town of Ramapo Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:	☐	☐	☐	
Stream stabilization - A few dozen feet to a few hundred feet.	☐	☐	☐	
Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)	☐	☐	☐	
Flood attenuation – A few dozen to several hundred feet	☐	☐	☐	
Riparian & wildlife habitat – A few dozen feet up to a mile, though the average minimum is approximately 100' to several hundred or a few thousand feet.	☐	☐	☐	
Protection of cold water fisheries – A few dozen feet to a few hundred feet	☐	☐	☐	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	☑	☐	☐	The code includes a Streams and Watercourses section prohibiting certain actions along these features.
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	☐	☐	☐	
Require restoration of impaired riparian zones as a condition of subdivision approval.	☐	☐	☐	
Restrict potentially problematic uses (Hazardous materials uses, for example)	☐	☐	☐	
Dedicate land for public facilities and services.	☐	☐	☐	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	☐	☐	☐	
Ensure utilities such as electric, natural gas, water and wastewater are hardened. Require electrical components to be mounted above flood levels. Major utility equipment should be considered a critical facility and be required to be located outside of the 500 year floodplain.	☐	☐	☐	
Consider the long-term needs of the community when discussing the potential for a homeowner's association to operate and/or maintain an area prone to flooding.	☐	☐	☐	
Require flood hazard information to be provided on a subdivision plat. Require the 100-year floodplain elevation to be shown on all subdivision plats. Information such as finished building pad elevation or proposed lowest finished floor elevation can also be detailed.	☐	☐	☐	
Any property with a floodplain should be required to show such information on the plan.	☐	☐	☐	
Require conservation easements around flood-prone areas or floodplains.	☐	☐	☐	
Require green infrastructure or low-impact development techniques, where feasible	☑	☐	☐	The code includes Stormwater Pollution Prevention Plan (SWPPP) requirements.
Each proposed lot must have a designated buildable site above the special flood hazard area (SFHA) as shown on the most current Flood Insurance Rate Map.	☐	☐	☐	

See Chapter 3 of this report for source information.

Code Sections Reviewed:

Flood Damage Prevention - Chapter 149

Stormwater Management and Sediment and Erosion Control - Chapter 237

Special Bulk Requirements - §376-42

Clustering - §376-43

Streams and Watercourses - Chapter 240

Table 6-6 Flood Resiliency Best Practices Code Audit Checklist				
Village of Wesley Hills Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	☐	☐	☐	
Use hedges and fencing to separate private and public realms. Screen on-site parking located beneath a structure with foundation plantings and vegetative screening. Screen piers and columns that have been used to raise structures.	☐	☐	☐	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	☐	☐	☐	
Building fronts, entry porches and similar features must use materials, colors and proportions appropriate for the local architectural context. Large and multi-family building should use treatments similar to ensure local architectural consistency.	☐	☐	☐	
Guidelines for specific design elements such as canopies, galleries, and local significant materials, colors and design strategies to mitigate height and size perceptions are encouraged.	☐	☐	☐	
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	☑	☐	☐	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces.
Permit relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	☐	☐	☐	
Enact new height limits where possible that are based on the new local design flood elevation (one to two feet over the BFE) where side and rear yard relief is possible.	☐	☐	☐	
Given the increased height of buildings due to elevation, turrets, towers and cupolas, ensure total building height does not exceed maximum height(s) desired, but also ensure that maximum building height requirements allow for building elevations without the need for a variance.	☐	☐	☐	
Require an additional 3' of freeboard above the base flood elevation for buildings within the Special Flood Hazard Area and 18" of freeboard in the "shaded X" area, which includes buildings between the 100-year and 500-year floodplains. All new single family detached dwellings outside of defined flood hazard areas need to be elevated 16-24". This approach acknowledges the likelihood of more extreme flooding inside of and more extensive flooding outside of the FEMA-defined flood hazard area (based on historic flooding and not sea-level rise).	☑	☐	☐	Standards are included that require between 2' and 3' above BFE in certain zones as well as requirements for drainage paths in other zones for residential structures. For non-residential structures, the lowest floor should be elevated 2' above BFE if no FIRM number is specified. Structures are to be floodproofed so that the structure is watertight below two feet above the base flood elevation, including utilities and sanitary facilities. Within the A, when no base flood data are available, the lowest floor (including basement) shall be elevated at least 3' above the highest adjacent grade.
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	☐	☐	☐	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	☐	☐	☐	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	☐	☐	☐	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	☐	☐	☐	

Table 6-6 Flood Resiliency Best Practices Code Audit Checklist				
Village of Wesley Hills Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Other Code Revisions				
Coastal Resilience Overlays could be applied to areas with the highest flood risk. These areas require higher elevations of the first floor, limit parking and hard pavement, and require additional landscaping and open space.	☑	☐	☐	This exists in a way in the code. Within special flood hazard areas, construction or improvements are prohibited without a valid floodplain development permit. For encroachments, assessments and/or a technical evaluation is required and when the Village agrees to apply to FEMA for conditional Firm and floodway revision and approval is received, only then can construction or substantial improvements move forward.
Upland Resilience Overlays could be applied to lower-risk areas capable of accommodating growth. New construction within an Upland Resilience Overlay is also permitted to reduce its own resilience requirements in exchange for placing conservation easements on higher-risk properties.	☑	☐	☐	
Neighborhood Resilience Overlays could be applied to lower-risk areas, and are intended for more typical cases. They allow for customized design standards that are appropriate to the local context.	☑	☐	☐	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	☐	☐	☐	
Ensure that well heads are above the BFE.	☑	☐	☐	The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system.
Add flood resistant construction (flood-proofing) standards such as ensuring buildings are watertight, utilities and sanitary facilities are above the BFE, enclosed within the building's watertight walls, or made watertight and resistance. Standards should also ensure that the building's structural components are also flood resistant.	☑	☐	☐	The Code requires anchoring of new structures and substantial improvements as well as the use of materials, utility equipment, and methods and practices that are resistant to flood damage and that minimize flood damage. Utilities must be at least 2' above BFE. Water supply systems must minimize or eliminate infiltration of floodwaters. On-site waste disposal systems must be located to avoid impairment to them, or contamination from them, during flood events.
Prohibit new development unless effect on flooding is minimal or zero.	☑	☐	☐	Code prohibits development encroachment if increases base flood by >1 foot (see encroachment note above). The code requires a details of any watercourse alteration or relocation. There are detailed permit application requirements including a technical analysis to determine whether or not proposed development will result in physical damage to any other property.
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	☐	☐	☐	
Consider acquisition of flood-prone lands, particularly where they include vital riparian areas and/or could provide a public benefit such as a park or passive open space.	☐	☐	☐	
Subdivision Ordinance Best Practices				
Subdivision Ordinance				
Conservation subdivision (cluster development) to encourage development be built in suitable areas of development that protects important natural features.	☐	☐	☐	
Prohibit subdivisions in floodprone areas.	☑	☐	☐	The Flood Damage Prevention Ordinance requires subdivisions to be consistent with the need to minimize flood damage, utilities and facilities must be located and constructed to minimize flood damage, and adequate drainage needs to be provided to reduce exposure to flood damage. There are code requirements that only a percentage of land underwater count toward minimum lot area. When no base flood elevation data are available from other sources, the permit applicant for a subdivision or other development shall provide the data for projects greater than 5 acres or 50 lots.

Table 6-6 Flood Resiliency Best Practices Code Audit Checklist				
Village of Wesley Hills Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:	☐	☐	☐	
Stream stabilization - A few dozen feet to a few hundred feet.	☐	☐	☐	
Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)	☐	☐	☐	
Flood attenuation – A few dozen to several hundred feet	☐	☐	☐	
Riparian & wildlife habitat – A few dozen feet up to a mile, though the average minimum is approximately 100' to several hundred or a few thousand feet.	☐	☐	☐	
Protection of cold water fisheries – A few dozen feet to a few hundred feet	☐	☐	☐	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	☐	☐	☐	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	☐	☐	☐	
Require restoration of impaired riparian zones as a condition of subdivision approval.	☐	☐	☐	
Restrict potentially problematic uses (Hazardous materials uses, for example)	☐	☐	☐	
Dedicate land for public facilities and services.	☐	☐	☐	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	☐	☐	☐	
Ensure utilities such as electric, natural gas, water and wastewater are hardened. Require electrical components to be mounted above flood levels. Major utility equipment should be considered a critical facility and be required to be located outside of the 500 year floodplain.	☐	☐	☐	
Consider the long-term needs of the community when discussing the potential for a homeowner's association to operate and/or maintain an area prone to flooding.	☐	☐	☐	
Require flood hazard information to be provided on a subdivision plat. Require the 100-year floodplain elevation to be shown on all subdivision plats. Information such as finished building pad elevation or proposed lowest finished floor elevation can also be detailed.	☐	☐	☐	
Any property with a floodplain should be required to show such information on the plan.	☐	☐	☐	
Require conservation easements around flood-prone areas or floodplains.	☐	☐	☐	
Require green infrastructure or low-impact development techniques, where feasible	☑	☐	☐	The code includes Stormwater Pollution Prevention Plan (SWPPP) requirements.
Each proposed lot must have a designated buildable site above the special flood hazard area (SFHA) as shown on the most current Flood Insurance Rate Map.	☐	☐	☐	

See Chapter 3 of this report for source information.

Code Sections Reviewed:

Flood Damage Prevention - Chapter 119

Subdivision of Land - Chapter 193

Stormwater Management - Chapter 181

Wetlands - Chapter 221

Table 6-7 Flood Resiliency Best Practices Code Audit Checklist				
Village of New Hempstead Preliminary Audit	*In Existing Code*	*Consider for Implementation*	*N/A*	*Notes*
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	☐	☐	☐	
Use hedges and fencing to separate private and public realms. Screen on-site parking located beneath a structure with foundation plantings and vegetative screening. Screen piers and columns that have been used to raise structures.	☐	☐	☐	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	☐	☐	☐	
Building fronts, entry porches and similar features must use materials, colors and proportions appropriate for the local architectural context. Large and multi-family building should use treatments similar to ensure local architectural consistency.	☐	☐	☐	
Guidelines for specific design elements such as canopies, galleries, and local significant materials, colors and design strategies to mitigate height and size perceptions are encouraged.	☐	☐	☐	
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	☑	☐	☐	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces.
Permit relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	☐	☐	☐	
Enact new height limits where possible that are based on the new local design flood elevation (one to two feet over the BFE) where side and rear yard relief is possible.	☐	☐	☐	
Given the increased height of buildings due to elevation, turrets, towers and cupolas, ensure total building height does not exceed maximum height(s) desired, but also ensure that maximum building height requirements allow for building elevations without the need for a variance.	☐	☐	☐	
Require an additional 3' of freeboard above the base flood elevation for buildings within the Special Flood Hazard Area and 18" of freeboard in the "shaded X" area, which includes buildings between the 100-year and 500-year floodplains. All new single family detached dwellings outside of defined flood hazard areas need to be elevated 16-24". This approach acknowledges the likelihood of more extreme flooding inside of and more extensive flooding outside of the FEMA-defined flood hazard area (based on historic flooding and not sea-level rise).	☑	☐	☐	Standards are included that require between 2' and 3' above BFE in certain zones as well as requirements for drainage paths in other zones for residential structures. For non-residential structures, the lowest floor should be elevated 2' above BFE if no FIRM number is specified. Structures are to be floodproofed including utilities and sanitary facilities. Within the A, when no base flood data are available, the lowest floor (including basement) shall be elevated at least 3' above the highest adjacent grade.
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	☐	☐	☐	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	☐	☐	☐	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	☐	☐	☐	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	☐	☐	☐	

Table 6-7 Flood Resiliency Best Practices Code Audit Checklist				
Village of New Hempstead Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Other Code Revisions				
Coastal Resilience Overlays could be applied to areas with the highest flood risk. These areas require higher elevations of the first floor, limit parking and hard pavement, and require additional landscaping and open space.	☑	☐	☐	This exists in a way in the code. Within special flood hazard areas, construction or improvements are prohibited without a valid floodplain development permit. For encroachments, assessments and/or a technical evaluation is required and when the Village agrees to apply to FEMA for conditional Firm and floodway revision and approval is received, only then can construction or substantial improvements move forward.
Upland Resilience Overlays could be applied to lower-risk areas capable of accommodating growth. New construction within an Upland Resilience Overlay is also permitted to reduce its own resilience requirements in exchange for placing conservation easements on higher-risk properties.	☑	☐	☐	
Neighborhood Resilience Overlays could be applied to lower-risk areas, and are intended for more typical cases. They allow for customized design standards that are appropriate to the local context.	☐ ✓	☐	☐	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	☐	☐	☐	
Ensure that well heads are above the BFE.	☑	☐	☐	The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system.
Add flood resistant construction (flood-proofing) standards such as ensuring buildings are watertight, utilities and sanitary facilities are above the BFE, enclosed within the building's watertight walls, or made watertight and resistance. Standards should also ensure that the building's structural components are also flood resistant.	☑	☐	☐	The Code requires anchoring of new structures and substantial improvements as well as the use of materials, utility equipment, and methods and practices that are resistant to flood damage and that minimize flood damage. Utilities must be at least 2' above BFE. Water supply systems must minimize or eliminate infiltration of floodwaters. On-site waste disposal systems must be located to avoid impairment to them, or contamination from them, during flood events.
Prohibit new development unless effect on flooding is minimal or zero.	☑	☐	☐	Code prohibits development encroachment if increases base flood by >1 foot (see encroachment note above). The code requires a details of any watercourse alteration or relocation. There are detailed permit application requirements including a technical analysis to determine whether or not proposed development will result in physical damage to any other property.
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	☐	☐	☐	
Consider acquisition of flood-prone lands, particularly where they include vital riparian areas and/or could provide a public benefit such as a park or passive open space.	☐	☐	☐	
Subdivision Ordinance Best Practices				
Subdivision Ordinance				
Conservation subdivision (cluster development) to encourage development be built in suitable areas of development that protects important natural features.	☐	☐	☐	
Prohibit subdivisions in floodprone areas.	☑	☐	☐	The Flood Damage Prevention Ordinance requires subdivisions to be consistent with the need to minimize flood damage, utilities and facilities must be located and constructed to minimize flood damage, and adequate drainage needs to be provided to reduce exposure to flood damage. There are code requirements that only a percentage of land underwater count toward minimum lot area. When no based flood elevation data are available from other sources, the permit applicant for a subdivision or other development shall provide the data for projects greater than 5 acres or 50 lots.

Table 6-7 Flood Resiliency Best Practices Code Audit Checklist				
Village of New Hempstead Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:	☐	☐	☐	
Stream stabilization - A few dozen feet to a few hundred feet.	☐	☐	☐	
Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)	☐	☐	☐	
Flood attenuation – A few dozen to several hundred feet	☐	☐	☐	
Riparian & wildlife habitat – A few dozen feet up to a mile, though the average minimum is approximately 100' to several hundred or a few thousand feet.	☐	☐	☐	
Protection of cold water fisheries – A few dozen feet to a few hundred feet	☐	☐	☐	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	☐	☐	☐	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	☐	☐	☐	
Require restoration of impaired riparian zones as a condition of subdivision approval.	☐	☐	☐	
Restrict potentially problematic uses (Hazardous materials uses, for example)	☐	☐	☐	
Dedicate land for public facilities and services.	☐	☐	☐	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	☐	☐	☐	
Ensure utilities such as electric, natural gas, water and wastewater are hardened. Require electrical components to be mounted above flood levels. Major utility equipment should be considered a critical facility and be required to be located outside of the 500 year floodplain.	☐	☐	☐	
Consider the long-term needs of the community when discussing the potential for a homeowner's association to operate and/or maintain an area prone to flooding.	☐	☐	☐	
Require flood hazard information to be provided on a subdivision plat. Require the 100-year floodplain elevation to be shown on all subdivision plats. Information such as finished building pad elevation or proposed lowest finished floor elevation can also be detailed.	☑	☐	☐	The Sketch Plat requirements don't specifically state that floodplain areas need to be shown but it appears to be implied and consistent with the requirements of the code and flooding is noted as an element of the character of a parcel that is of importance to the Village.
Any property with a floodplain should be required to show such information on the plan.	☐	☐	☐	
Require conservation easements around flood-prone areas or floodplains.	☐	☐	☐	
Require green infrastructure or low-impact development techniques, where feasible	☑	☐	☐	The code includes Stormwater Pollution Prevention Plan (SWPPP) requirements.
Each proposed lot must have a designated buildable site above the special flood hazard area (SFHA) as shown on the most current Flood Insurance Rate Map.	☐	☐	☐	

See Chapter 3 of this report for source information.

Code Sections Reviewed:

Flood Damage Prevention - Chapter 154

Subdivision of Land - Chapter 255

Stormwater Management and Erosion and Sediment Control - Chapter 245

Freshwater Wetlands - Chapter 159

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