



Department of
Environmental Conservation



Office of
General Services

Design &
Construction

FLOOD MITIGATION & RESILIENCE REPORT

Mahwah River - SD111

Prepared for:

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

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New York State Office of General Services
Empire State Plaza
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ACRONYMS

BFE	Base Flood Elevation
BIN	Bridge Identification Number
CFS	Cubic Feet per Second
CMP	Corrugated Metal Pipe
DHSES	NYS Department of Homeland Security and Emergency Services
DWSP2	Drinking Water Source Protection Program
EPOD	Environmental Protection Overlay District
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
GEIS	Generic Environmental Impact Statement
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center – <i>River Analysis System</i>
HMP	Hazard Mitigation Plan
HRA	High Risk Area
LIDAR	Light Detection and Ranging
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
RCP	Representative Concentration Pathways
SEQRA	State Environmental Quality Review Act
SFHA	Special Flood Hazard Area
SIR	Scientific Investigations Report
SRL	Severe Repetitive Loss
STA	Station (river)
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WSP	Water Supply Paper

SUMMARY

This analysis of the Mahwah River is being conducted as part of the Resilient New York Program, an initiative of the New York State Department of Environmental Conservation. The Mahwah River originates in central Rockland County and drains southward into New Jersey. The Mahwah River watershed is 26 square miles in size at its confluence with the Ramapo River in New Jersey. An area of 21.7 square miles, or just over 83 percent of the watershed, is located within New York State. The watershed is located north-northwest of New York City and is part of the New York Metropolitan Area. Forested land is the most common land cover, representing 48 percent of the watershed, followed by developed land, which makes up 43 percent of the land cover in the watershed. The watershed includes 641 acres of wetlands, or approximately 4.6 percent of the watershed. Wetlands play an important role in flood mitigation by storing water and attenuating peak flows.

Rockland County, including the Mahwah River 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. Annual peak flow on the Mahwah River, recorded since 1959 at a stream gauge located at the U.S. Route 202 bridge over the Mahwah River, provides a useful view of flood events. Tropical Storm Irene, which hit Rockland County on August 28, 2011, was by far the highest flow recorded at the Mahwah River gauging station since recording began in 1959. The flow exceeded the 100-year flood event at this location.

As part of this analysis, flood-prone High Risk Areas, or HRAs, within the Mahwah River 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. Much of the analysis focuses on stream crossings, where roads cross over the Mahwah River or its tributaries, and the watercourse is conveyed under the roadway through a bridge or culvert. A number of stream crossings are identified as being hydraulically undersized and are recommended for replacement.

It is noted in the analysis that Federal Emergency Management Agency (FEMA) hydraulic modeling for the Mahwah River is based on an antiquated HEC-2 analysis dating from the 1980s. It is recommended that new FEMA modeling for the Mahwah River be developed to reflect current hydraulic and hydrologic conditions. The updated hydraulic modeling would reflect changes such as bridge replacements, flood mitigation projects, and updated flood hydrology.

An analysis of watershed land use is conducted, and a Flood Resiliency Best Practices Audit is conducted for each community within the watershed. Results of the audit are summarized in a series of tables.

The village of Suffern, located within the lower portion of the Mahwah River watershed, is a Drinking Water Source Protection Program participant. Efforts to identify and map drinking water source protection areas should include wetlands and floodplains in the Mahwah River watershed that may have the mutual benefit of providing drinking water source protection and flood mitigation services.

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.

The Mahwah River originates in central Rockland County and drains southward into New Jersey. This report will focus on the portion of the Mahwah River watercourse and watershed that is located within New York State. The report begins with an overview of the Mahwah River 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 replacement of undersized bridges and culverts, road closures, and individual property protection measures 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.

The Mahwah River watershed measured at its confluence with the Ramapo River in New Jersey is 26 square miles in size. An area of 21.7 square miles, or just over 83 percent of the watershed, is located within New York State. While this study focuses on flooding issues in the portion of the watershed located in New York State, recommendations include some actions in New Jersey.

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 the Mahwah River and its tributaries.

2. DATA COLLECTION

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

2.1 MAHWAH RIVER WATERSHED CHARACTERISTICS

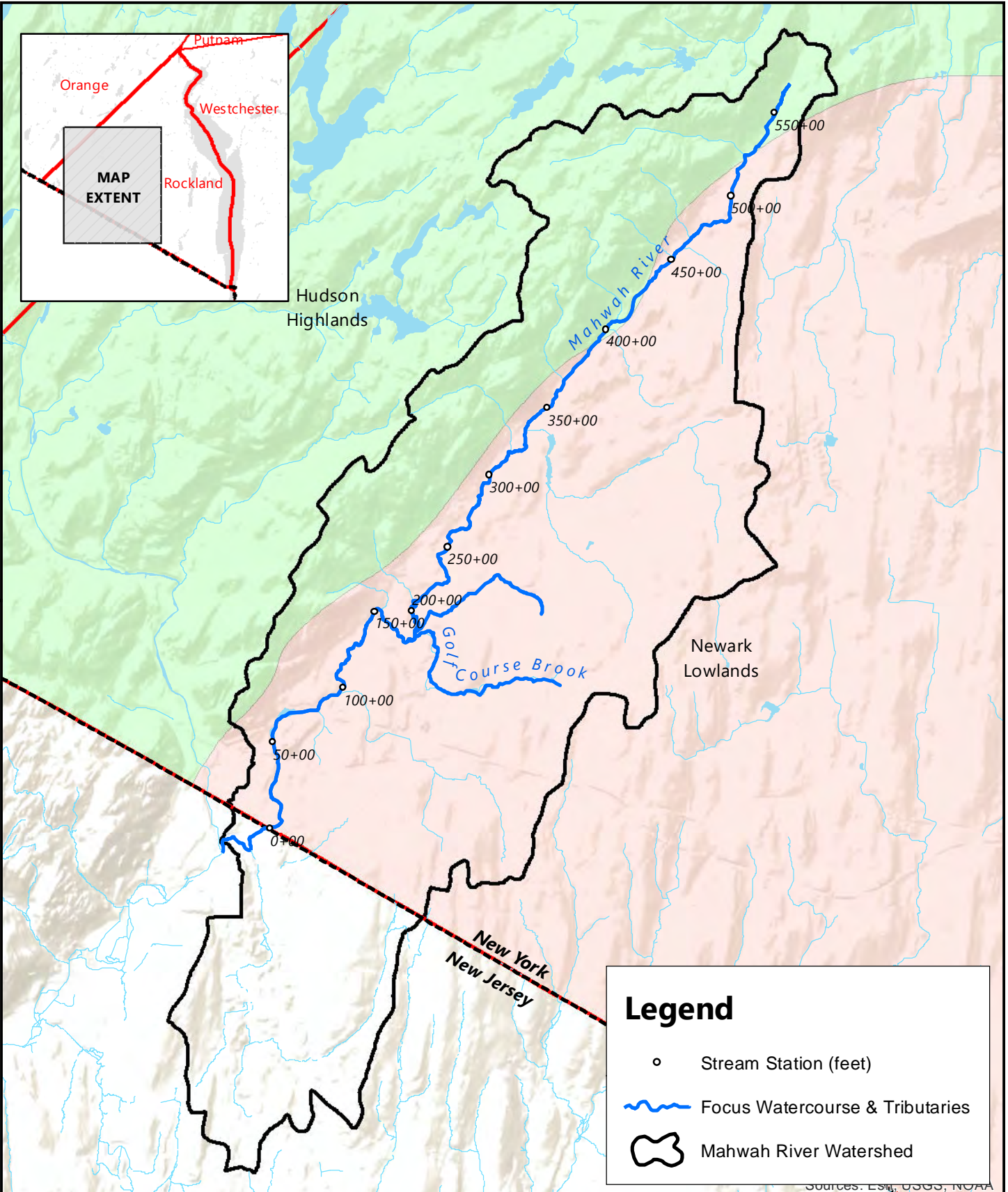
The Mahwah River watershed is located in Rockland County, in southeastern New York State. The eastern, more low-lying portion of the watershed falls within the physiographic region of New York State known as the Newark Basin or Newark Lowlands while the higher elevation lands of the Ramapo Mountains in the western portion of the watershed fall within the Hudson Highlands physiographic region (Figure 2-1).

The watershed is oblong in shape and flows in a generally southwesterly direction, draining a portion of central and southwestern Rockland County before flowing into New Jersey and joining the larger Ramapo River. Portions of the towns of Haverstraw and Ramapo and the villages of Pomona, Wesley Hills, Hillburn, New Hempstead, Suffern, and Montebello drain to the Hackensack River. The watershed is bounded to the west by the Ramapo Mountains, which form the divide between the Mahwah and Ramapo River watersheds, and to the north by a series of hills including Breakneck Mountain, Ladentown Mountain, Horsechock Mountain, and Cheesecote Mountain. The eastern boundary of the watershed runs through the urbanized areas of Ramapo and Suffern and separates the Mahwah River watershed from the Hackensack River, Saddle River, and Minisceongo Creek watersheds.

When measured at its confluence with the Ramapo River in New Jersey, the Mahwah River watershed is 26 square miles in size. An area of 21.7 square miles, or just over 83 percent of the watershed, is located within New York State and is the focus of this study. Figure 2-2 is a watershed map of the Mahwah River watershed. Figure 2-3 is a relief map depicting the topography of the watershed.

Bedrock underlying the eastern, more low-lying portion of the Mahwah River watershed is mapped as Hammer Creek Formation, a conglomerate classified as part of the Newark Group dating from the Upper Triassic. The higher lands that form the Ramapo Mountains in the western portion of the watershed are underlain by Hornblende granite and granite gneiss dating from the Middle Proterozoic. Bands of bedrock that run along the western edge of the watershed atop the Ramapo Mountains are mapped as pyroxene-hornblende-quartz-plagioclase gneiss, also dating from the Middle Proterozoic. Two small areas of the watershed, one at Pomona Heights and the other in Suffern, are underlain by Ladentown Diabase.

Surficial materials underlying the Mahwah River watershed consist primarily of glacial till, with areas mapped as exposed bedrock occurring on Ramapo Mountain. Areas mapped as outwash sand and gravel underlie the Mahwah River valley bottom, both in the upper watershed in Haverstraw and near the state line in Suffern. An area mapped as alluvium also occurs along the western edge of the valley bottom, near the state line in Suffern.



Legend

- Stream Station (feet)
- Focus Watercourse & Tributaries
- Mahwah River Watershed

Sources: ESRI, USGS, NOAA

231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

PHYSIOGRAPHIC REGIONS

MAHWAH RIVER FLOOD & RESILIENCY STUDY
SD111
ROCKLAND COUNTY
NEW YORK

0 3,000 6,000
Feet

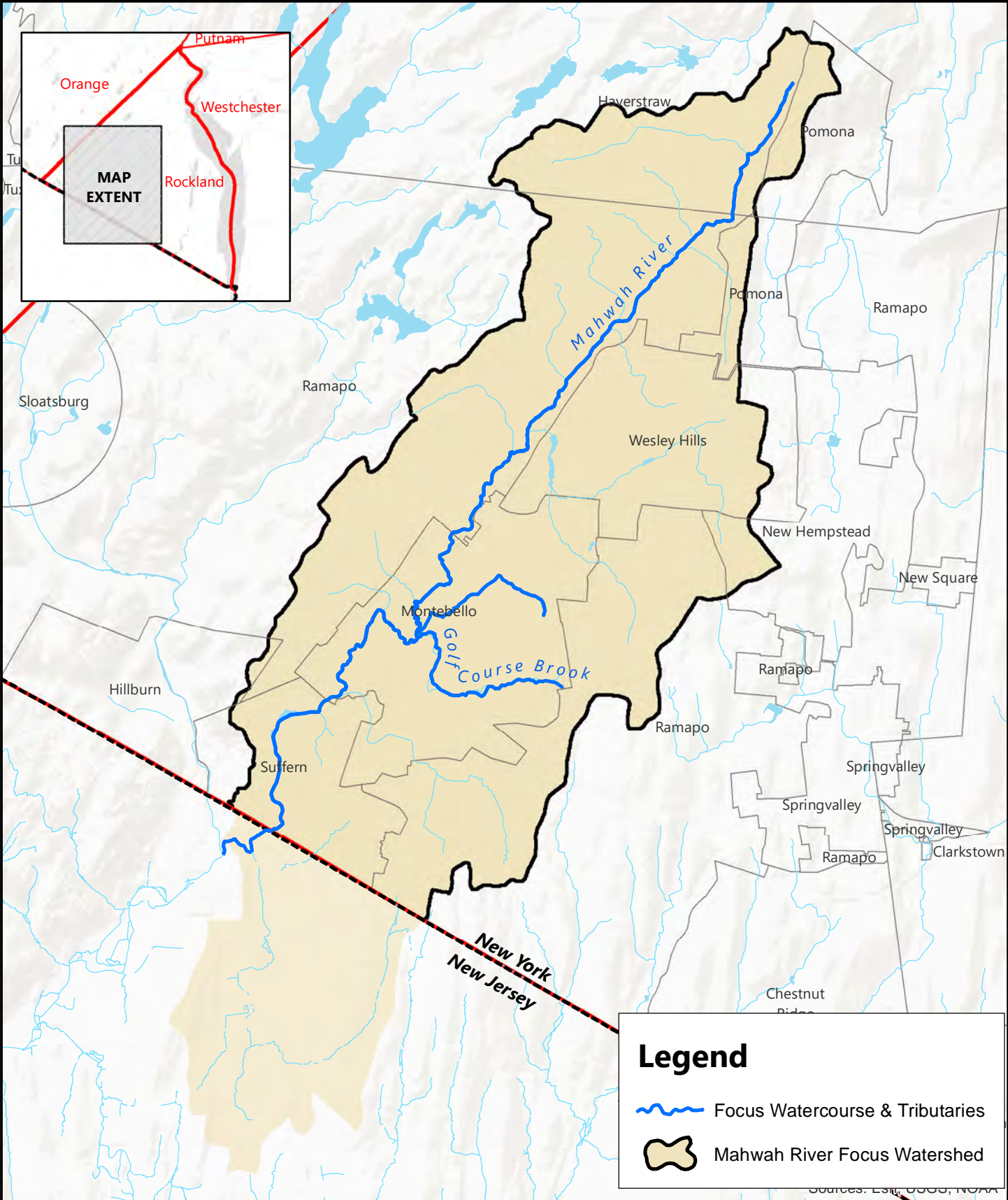
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SCALE 1" = 6,500'

DATE 8/18/2021

PROJ. NO. 16511.00006

FIG. 2-1



Legend

- Focus Watercourse & Tributaries
- Mahwah River Focus Watershed

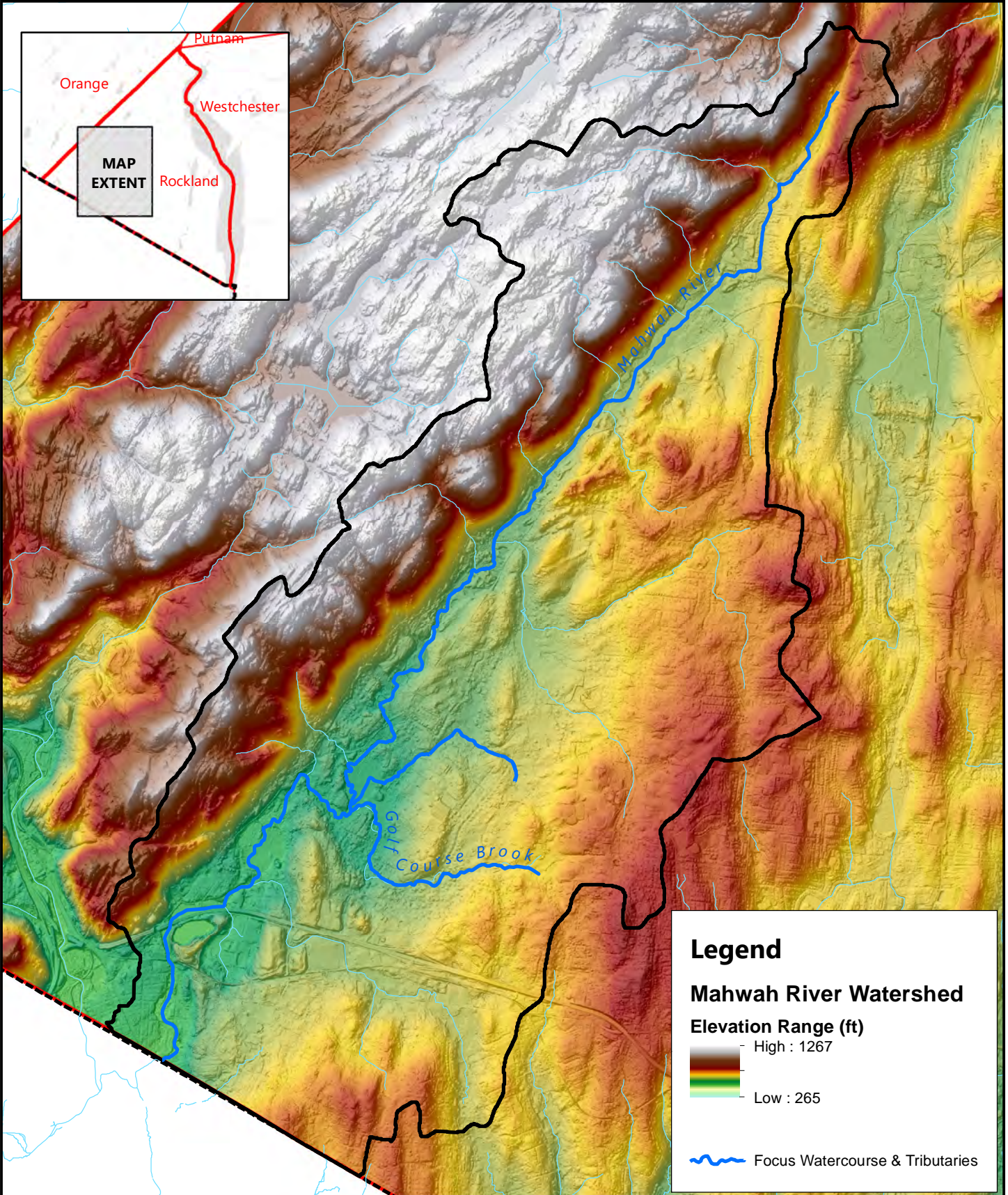
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NEW PALTZ, NY 12561
845.633.8153

MAHWAH RIVER WATERSHED MAP
MAHWAH RIVER FLOOD & RESILIENCY STUDY
SD111
ROCKLAND COUNTY
NEW YORK

0 3,000 6,000
Feet

FIG. 2-2

SCALE 1" = 6,500'
DATE 6/29/2021
PROJ. NO. 16511.00006

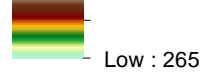


Legend

Mahwah River Watershed

Elevation Range (ft)

High : 1267



Low : 265

Focus Watercourse & Tributaries



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845.633.8153

RELIEF MAP

MAHWAH RIVER FLOOD & RESILIENCY STUDY
SD111
ROCKLAND COUNTY
NEW YORK



SCALE 1" = 5,000'

DATE 6/29/2021

16511.00006
PROJ. NO.

FIG. 2-3

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 Mahwah River watershed. The hydrologic soil group B is most prevalent, followed by the hydrologic soil group C. Combined, these two hydrologic soil groups make up 83 percent of the watershed.

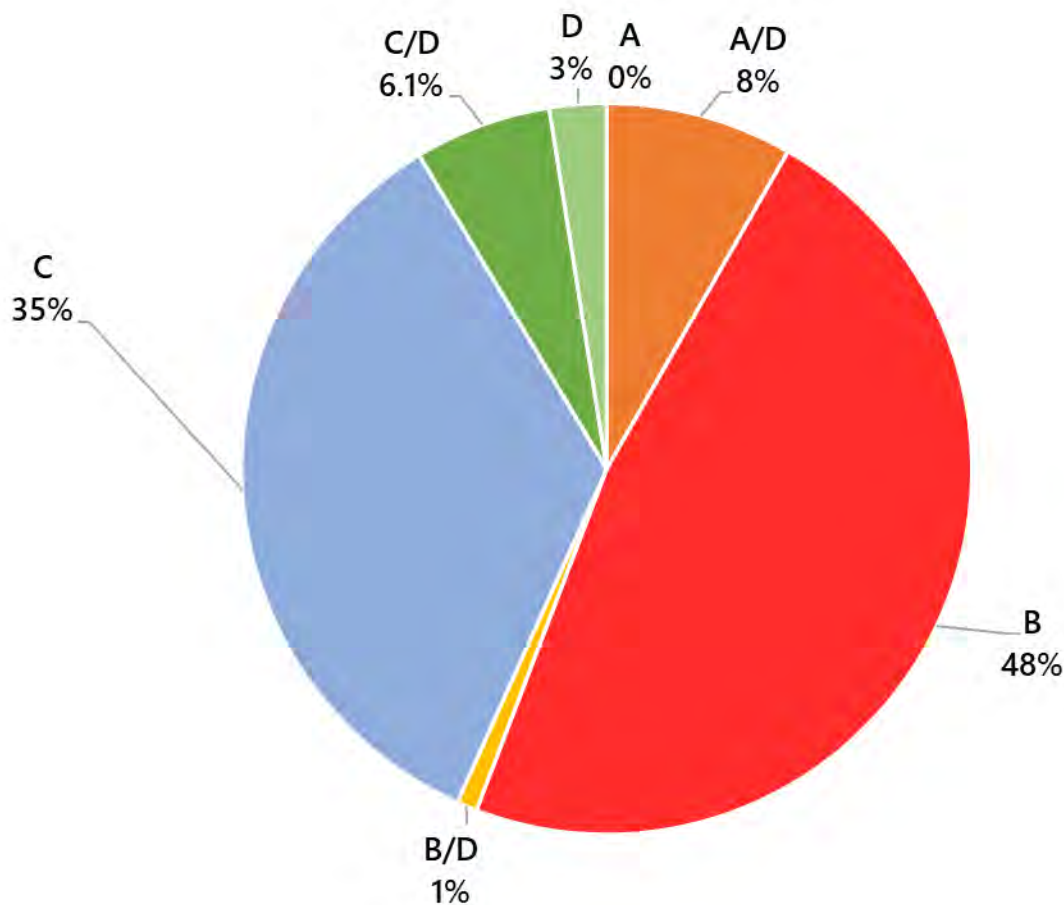


Figure 2-4 Hydrologic Grouping of Soils within the Mahwah River Watershed

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 Mahwah River 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. Forested land, which consists of deciduous, coniferous, and mixed forest

types, is the most common land cover, representing 48 percent of the watershed. Developed land makes up 43 percent of the land cover in the watershed. Open water and wetlands combined make up 8 percent of the land cover. The remaining 1 percent of the land cover consists of agricultural land, grassland and shrubland, and barren land.

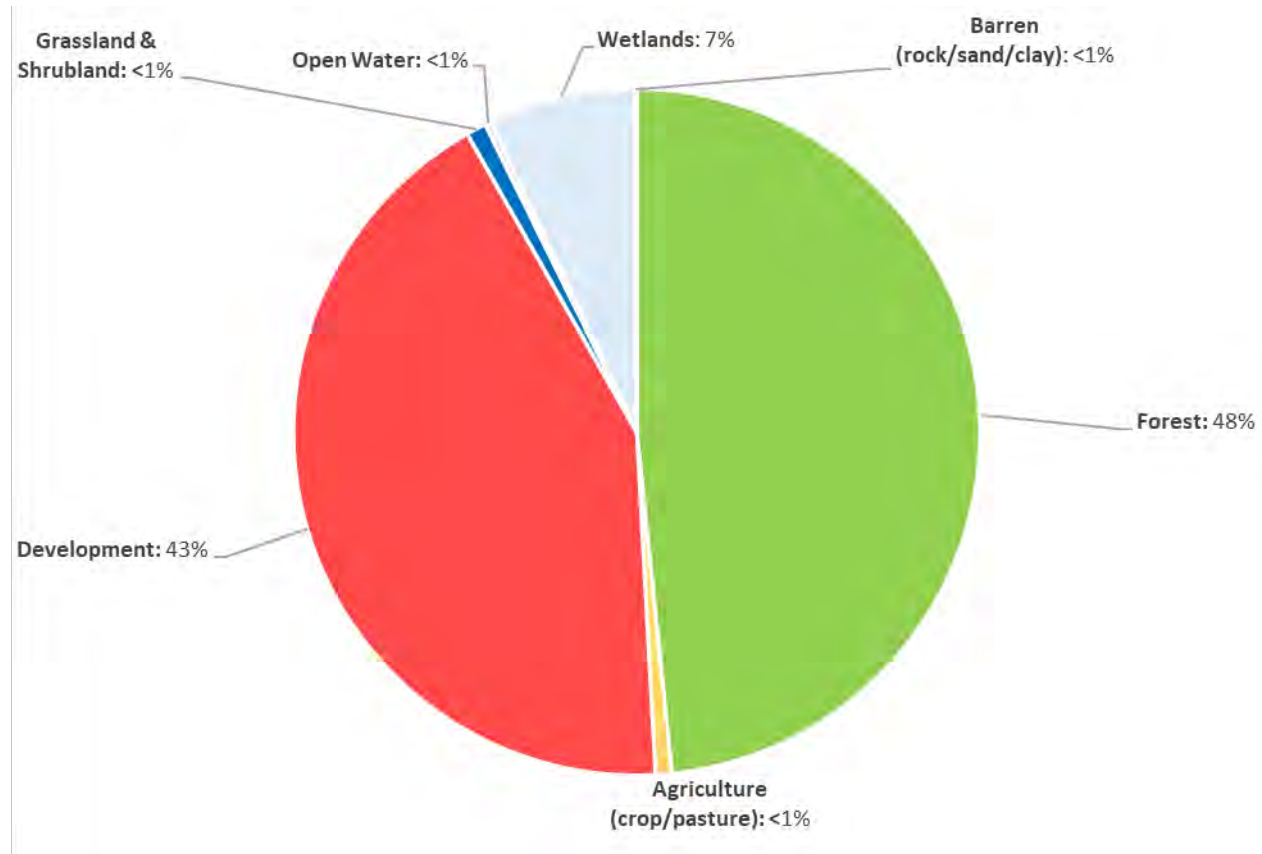


Figure 2-5 Land Cover within the Mahwah River Watershed

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 641 acres of wetlands in the Mahwah River watershed, or approximately 4.6 percent of the watershed. This amount includes the following types of wetland habitats: freshwater forest/shrub wetland, freshwater emergent wetland, freshwater ponds, and riverine wetland. Wetlands in the watershed include several swamps in the upper watershed including Green Swamp and Squirrel Swamp. 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. The watershed has few large waterbodies. Lake Antrim is located adjacent to Interstate 87. There are smaller ponds throughout the watershed.

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.

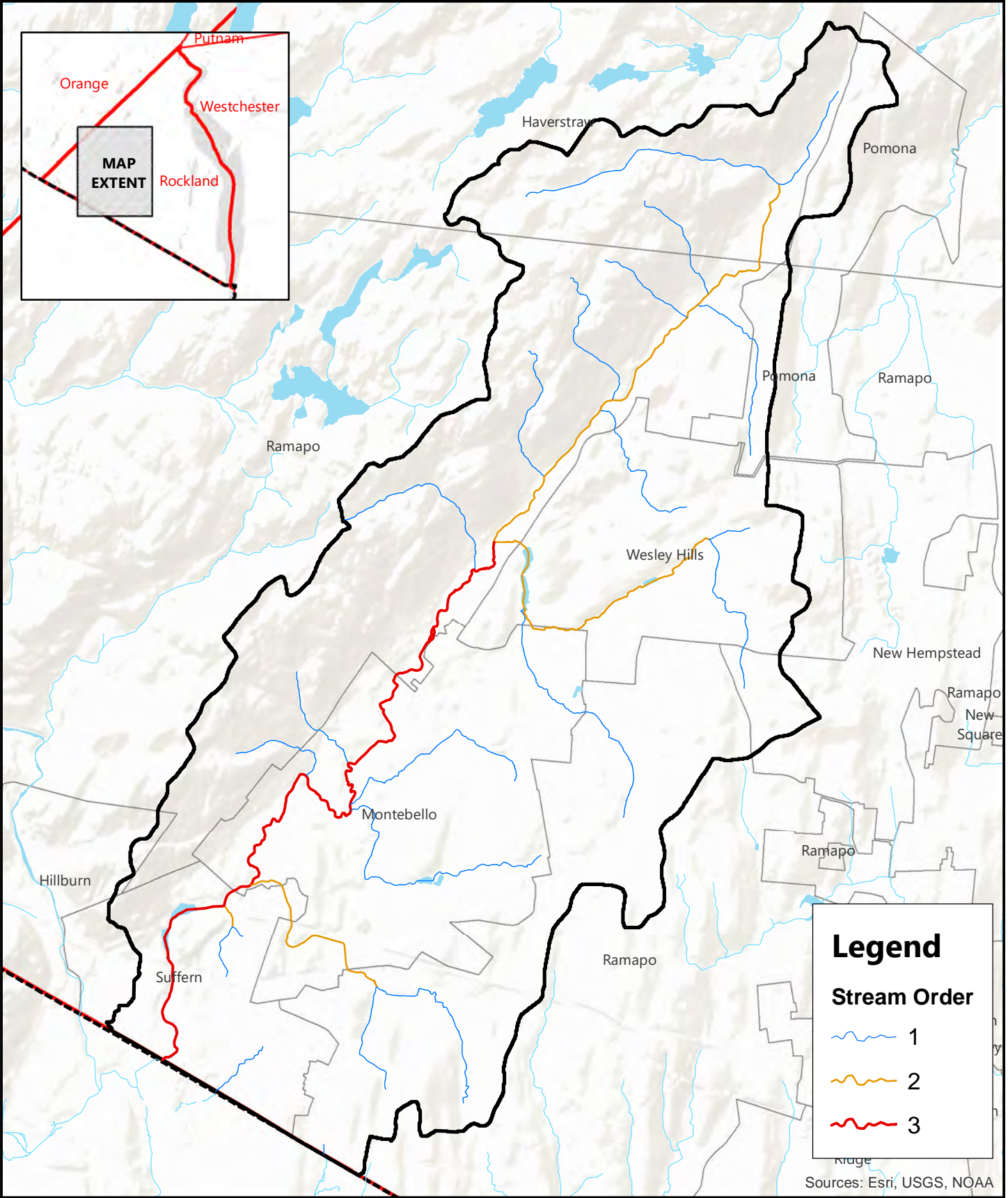
2.2 MAHWAH RIVER WATERCOURSE

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 Mahwah River originates as a first-order stream in the town of Haverstraw and transitions to a second-order stream where it is joined by a tributary flowing from File Factory Hollow. It continues flowing in a southwesterly direction through Ramapo, where it transitions to a third-order stream and continues through Montebello and Suffern before crossing into New Jersey. After crossing into New Jersey, the Mahwah River is joined by another third-order stream and becomes a fourth-order stream before emptying to the Ramapo River. Figure 2-6 is a map depicting stream order in the Hackensack River watershed in New York State.

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 Mahwah River watershed (82 percent). First-order streams are steeper in slope than second-order streams, which are steeper than the third-order main stem of the Mahwah River. Tributaries entering the Mahwah River from the west, which originate on the steep slopes of the Ramapo Mountains, are generally steeper than those entering from the east.




Table 2-1 Stream Order Characteristics in the New York State Portion of the Mahwah River Watershed

Stream Order	Total Length (miles)	Percentage of Overall Network Length (%)	Average Slope (%)
1 st	23.5	62	3.0
2 nd	7.8	20	1.2
3 rd	6.8	18	0.3
Total	38.1	100	



Legend

Stream Order

-  1
-  2
-  3

Sources: Esri, USGS, NOAA



231 MAIN STREET
 SUITE 102
 NEW PALTZ, NY 12561
 845.633.8153

WATERSHED STREAM ORDER

MAHWAH RIVER FLOOD & RESILIENCY STUDY
 SD111
 ROCKLAND COUNTY
 NEW YORK



0 2,000 4,000
 Feet

SCALE 1" = 5,000'

DATE 6/24/2021

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FIG. 2-6

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.

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 snow pack or soil saturation, can impact the timing, duration, and severity of flooding.

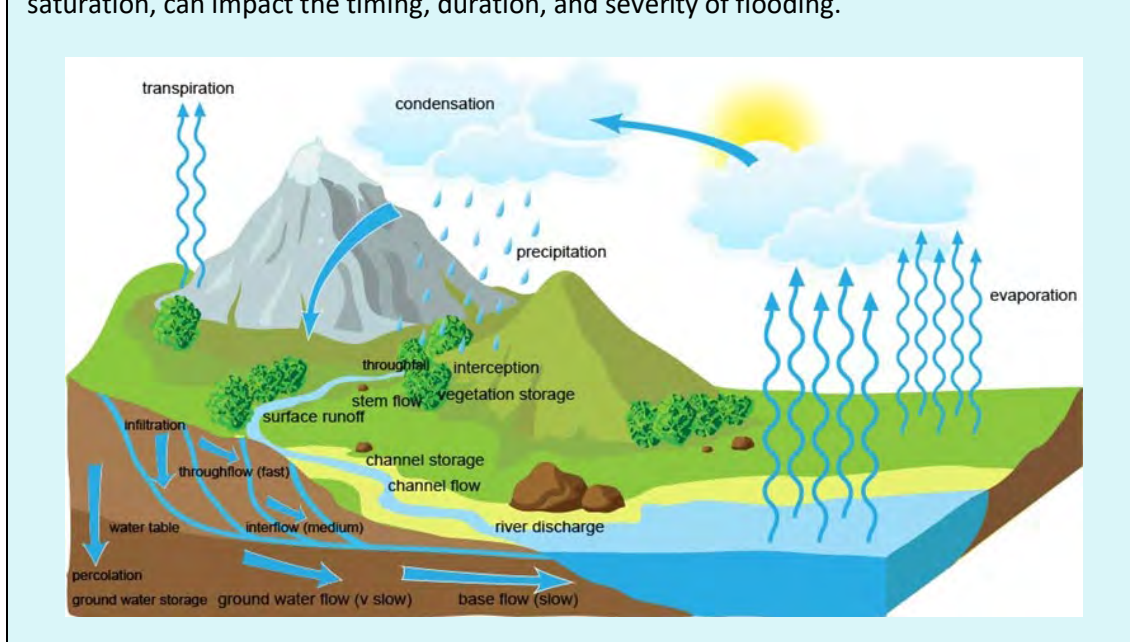


Figure 2-7 Diagram of Simplified Hydrologic Cycle

Flood hydrology for the Mahwah River was taken from the effective Flood Insurance Studies (FIS) for Rockland County, New York (36087CV001A) and Bergen County, New Jersey (34003CV001B). Discharge estimates at various locations along the river 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 Golf Course Brook were obtained from the FIS as well and were calculated using the 2006 New York regional regression equations combined with the USGS WSP 2207 urban regression equations and considering the rational method for watersheds of less than 1 square mile drainage area. Flood flows on the Mahwah River and Golf Course Brook are presented in Tables 2-2 and 2-3, respectively. Flood hydrology for the upper portion of the Mahwah River above the confluence of Golf Course Brook, as it flows through HRA 4, was updated using stream gauge data and is discussed further in Section 4.4 of this report.

Table 2-2: Flood Hydrology for the Mahwah River Developed for the Rockland County FIS (36087CV001A)¹ and the Bergen County, New Jersey, FIS (34003CV001B)²

Location	Drainage Area (sq. mi.)	Peak Flood Discharge (cfs)			
		10-year	50-year	100-year	500-year
At confluence with Ramapo River ²	26.0	3,309	5,005	5,800	7,583
At NY-NJ boundary ²	21.2	2,098	3,753	4,631	7,167
At Village of Suffern - Village of Montebello corporate limits ¹	19.50	1,810	3,400	4,320	7,200
Upstream of confluence of Golf Course Brook ¹	14.20	1,420	2,680	3,400	5,680

Table 2-3: Flood Hydrology for Golf Course Brook 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 Mahwah River	1.79	570	900	1,100	1,620
Approximately 260 feet upstream of Nottingham Drive	1.65	480	762	930	1,370
Approximately 110 feet downstream of Brigadoon Drive	0.96	410	640	780	1,150
Approximately 90 feet upstream of Mile Road	0.85	381	530	660	970
At west border of Spook Rock Golf Course	0.51	320	450	520	670

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 Mahwah River watershed, were applied to corresponding flood flows used in this analysis. The flows based on the more moderate greenhouse gas scenario were used in hydraulic models. Proposed replacement stream crossings were assessed based on the flood flows the structure would be expected to encounter over its design lifetime. When modeling culverts, the 2050-2074 projections were employed, as a 50-year design life is typical for such structures; the 2075-2099 projections were used for bridges, which are often in service for 75 to 100 years or more. Mean estimated increases on the Mahwah River at the New York-New Jersey state line 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 for the Mahwah River and Golf Course Brook at various locations along the watercourses are compared in Table 2-5 and Table 2-6, respectively. Current and predicted future flows for the upper portion of the Mahwah River above the confluence of Golf Course Brook, as it flows through HRA 4, are discussed further in Section 4.4 of this report.

Table 2-4: Projected Increases in Flood Flows on the Mahwah River

Mean Change in Discharge (%)	2025-2049		2050-2074		2075-2099	
	50-Year Flood	100-Year Flood	50-Year Flood	100-Year Flood	50-Year Flood	100-Year Flood
Greenhouse Gas Scenario						
RCP 4.5	9	9	12	12	10	10
RCP 8.5	8	9	10	10	15	15

Table 2-5: Current and Projected Future Design Flood Flows Used in Hydraulic Analyses on the Mahwah River

Location	Peak Flood Discharge (cfs)			
	Current		Projected Future (RCP 4.5, 2075-2099)	
	50-Year	100-Year	50-Year	100-Year
At confluence with Ramapo River	5,005	5,800	5,506 (+10%)	6,380 (+10%)
At NY-NJ boundary	3,753	4,631	4,128 (+10%)	5,094 (+10%)
At Village of Suffern - Village of Montebello corporate limits	3,400	4,320	3,740 (+10%)	4,752 (+10%)
Upstream of confluence of Golf Course Brook	2,680	3,400	3,002 (+12%)	3,842 (+13%)

Table 2-6: Current and Projected Future Design Flood Flows Used in Hydraulic Analyses on Golf Course Brook

Location	Peak Flood Discharge (cfs)			
	Current		Projected Future (RCP 4.5, 2050-2074)	
	50-Year	100-Year	50-Year	100-Year
At confluence with Mahwah River	900	1,100	990 (+10%)	1,221 (+11%)
Approximately 260 feet upstream of Nottingham Drive	762	930	838 (+10%)	1,023 (+11%)
Approximately 110 feet downstream of Brigadoon Drive	640	780	704 (+10%)	866 (+11%)
Approximately 90 feet upstream of Mile Road	530	660	583 (+10%)	726 (+10%)
At west border of Spook Rock Golf Course	450	520	495 (+10%)	572 (+10%)

2.4 HYDRAULICS

To develop hydraulic modeling to assess flood mitigation alternatives, effective FEMA HEC-RAS hydraulic models were sought for areas of the Mahwah River watershed where they were available, which is limited to Golf Course Brook in Rockland County, New York, and for the Mahwah River in Bergen County, New Jersey. These models were obtained from the NYSDEC, Floodplain Management Section, Bureau of Flood Protection and Dam Safety, which is gratefully acknowledged.

Effective FEMA modeling of the Mahwah River in New Jersey was completed in 2013 as part of the Bergen County, New Jersey, FIS (34003CV001B). This HEC-RAS model extends from the New York state line to the Mahwah's confluence with the Ramapo River approximately 3,500 feet downstream.

Hydraulic analyses on Golf Course Brook and the New Jersey section of the Mahwah River were conducted using the HEC-RAS computer software. This program was developed by the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center and is the industry standard for riverine flood analysis. The model is used to compute water surface profiles for one- and two-dimensional, steady- and unsteady-state flow conditions. The system can accommodate a full network of channels, a dendritic system, or a single river reach. HEC-RAS is capable of modeling water surface profiles under subcritical, supercritical, and mixed-flow conditions. Water surface profiles are computed from one cross section to the next by solving the one-dimensional energy equation with an iterative procedure called the standard step method. Energy losses are evaluated by friction (Manning's Equation) and the contraction/expansion of

flow through the channel. The momentum equation is used in situations where the water surface profile is rapidly varied such as hydraulic jumps, mixed-flow regime calculations, hydraulics of dams and bridges, and evaluating profiles at a river confluence.

Model geometry was based on a combination of surveyed channel cross sections included in effective FEMA modeling, field measurements by SLR, and Light Detection and Ranging (LiDAR)-derived topographic mapping from the New York State (NYS) Geographic Information System (GIS) Clearinghouse. Roughness coefficients were applied to the model domain based on field observations and aerial orthophotography.

The main stem of the Mahwah River in New York was last modeled in the 1980s using the antiquated HEC-2 software. To evaluate stream crossings on the Mahwah River main stem, the HY-8 culvert hydraulics software was used. This program 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.

2.5 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 and county and municipal staff and included participation from NYSDEC, NYSOGS, Rockland County, and watershed towns and villages. 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, one-on-one conversations took place with representatives from the watershed municipalities and groups.

2.6 INFRASTRUCTURE

Several bridge and culvert crossings of the Mahwah River and Golf Course Brook are contained within identified HRAs and in certain cases may contribute to flooding in these locations. These structures and summary details are listed below in Table 2-7. A number of additional structures span the streams but were not assessed in detail because they were adequate or did not significantly increase the flood hazard in the surrounding areas.

Table 2-7: Summary Data for Assessed Bridge and Culvert Crossings of Mahwah River and Golf Course Brook

River	Roadway	River Station (ft)	Structure	NBI BIN* (Owner)	Number of Spans/Barrels	Span (ft)	Bankfull Width (ft) (Regional Regressions)
Mahwah River	Franklin Turnpike (NJ)	-6+25 (NJ)	Conc. Arch Bridge	020033B (County)	1	40	59
	Norfolk Southern Railroad (NJ)	-8+00 (NJ)	Riveted Steel Beam Bridge	N/A (Railroad)	1	52	59
	Montebello Road bridge	92+00	Conc. Beam Bridge	3346120 (County)	1	47.5	57
	Sky Meadow Road	320+50	Conc. Box Culvert	Not Listed (Town)	1	15.5	48
			Corrugated Metal Pipe Arch Culverts	Not Listed (Town)	2	3.6 span 2.4 rise	
	Mountain Road	475+00	Corrugated Metal Pipe Arch Culvert	Not Listed (Town)	1	20.4	30
Round Smooth Lined Plastic Pipe Culvert			Not Listed (Town)	1	3 dia.		
Golf Course Brook	Nottingham Drive	22+50	Conc. Box Culvert	Not Listed (Village)	1	9.0 span 4.0 rise	28
	East Mayer Drive	28+00	Conc. Box Culvert	Not Listed (Village)	1	9.0 span 3.8 rise	28
	Heather Hills Lane	33+50	Conc. Box Culvert	Not Listed (Village)	2	10.6 span 2.7 rise	28
	Robin Hood Road	40+00	Conc. Box Culvert	Not Listed (Village)	1	8 span 4.25 rise	28
	Brigadoon Drive	45+00	Conc. Box Culvert	Not Listed (Village)	1	8.3 span 4.0 rise	28
	Mile Road	52+00	Conc. Box Culvert	Not Listed (Village)	1	16.4 span 3.8 rise	28

*NBI BIN = National Bridge Inventory Bridge Identification Number

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 Flood Insurance Study (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 Mahwah River watershed. The flood history is summarized from the FEMA Flood Insurance Study for Rockland County and the Rockland County Multi-Jurisdictional Hazard Mitigation Plan.

Table 3-1 Mahwah River 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 16, 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 \$14.6 million. Rainfall amounts from 3.16 inches at Nanuet to 3.31 inches at New City. The Mahwah River at Suffern was above its flood stage of 4 feet from 1:30 p.m. on September 16 until 3 a.m. on September 18. The crest stage was about 9.7 feet.
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.
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	<p>Hurricane Irene formed from a tropical wave on August 21, 2011, in the tropical Atlantic Ocean. It moved west-northwestward before becoming a hurricane. Irene struck Puerto Rico as a tropical storm. Hurricane Irene steadily strengthened to reach peak winds of 120 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.</p> <p>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.</p> <p>\$296 million in damages across New York State, 7.52 inches of rainfall recorded at Tappan, New York</p> <p>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 New York State released untreated wastewater into tributaries or the Hudson itself.</p> <p>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.</p> <p>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.</p>

Date	Flood Event	Notes
October 29, 2012	Superstorm Sandy	<p>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. It was 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.</p> <p>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 United States is estimated at over \$100 billion (2013 USD).</p> <p>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.</p>

Annual peak flow on the Mahwah River near Suffern, recorded since 1959 at the USGS gauge (01387450) located on the left bank just upstream from the bridge on U.S. Route 202, provides a useful view of flood events. 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. Figure 3-1 is a hydrograph showing annual peak flows recorded. Tropical Storm Irene, which hit Rockland County on August 28, 2011, was by far the highest flow recorded at the Mahwah River gauging station since recording began in 1959. The flow exceeded the 100-year flood event at this location.

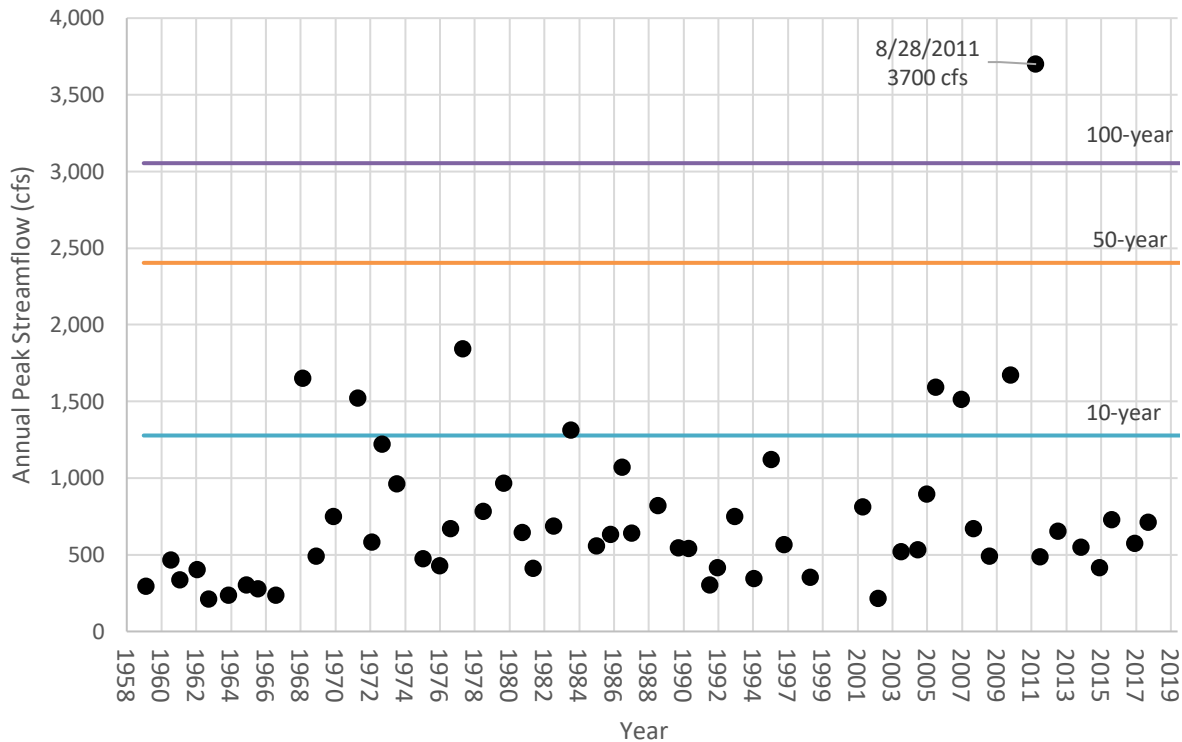


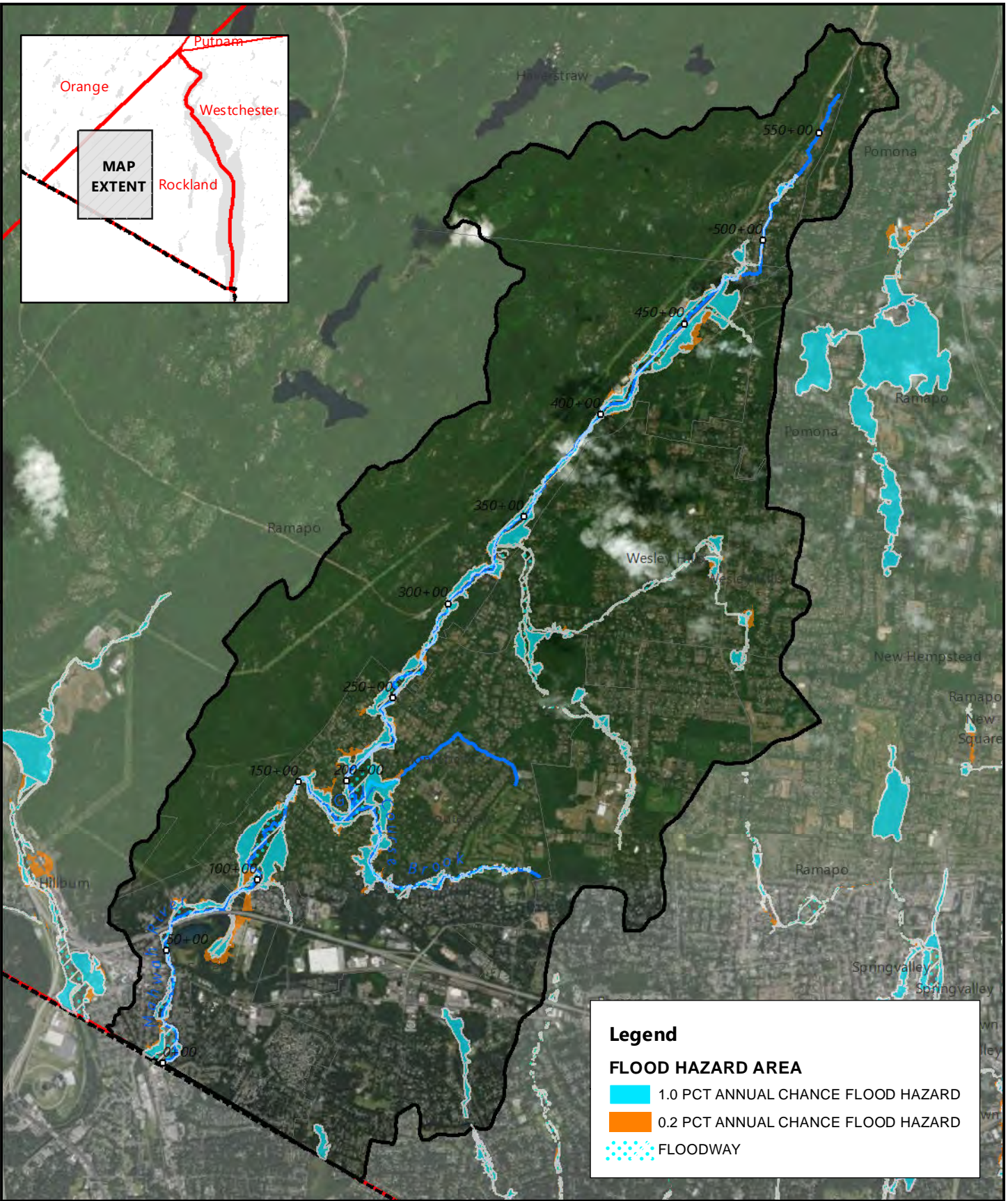
Figure 3-1 Hydrograph of Annual Peak Flow on the Mahwah River at Suffern 1959 – 2018

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. The flood hazard areas delineated by FEMA are mapped in Figure 3-2. 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.



Legend

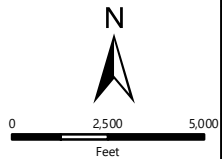
FLOOD HAZARD AREA

- 1.0 PCT ANNUAL CHANCE FLOOD HAZARD
- 0.2 PCT ANNUAL CHANCE FLOOD HAZARD
- FLOODWAY

SLR
 231 MAIN STREET
 SUITE 102
 NEW PALTZ, NY 12561
 845.633.8153

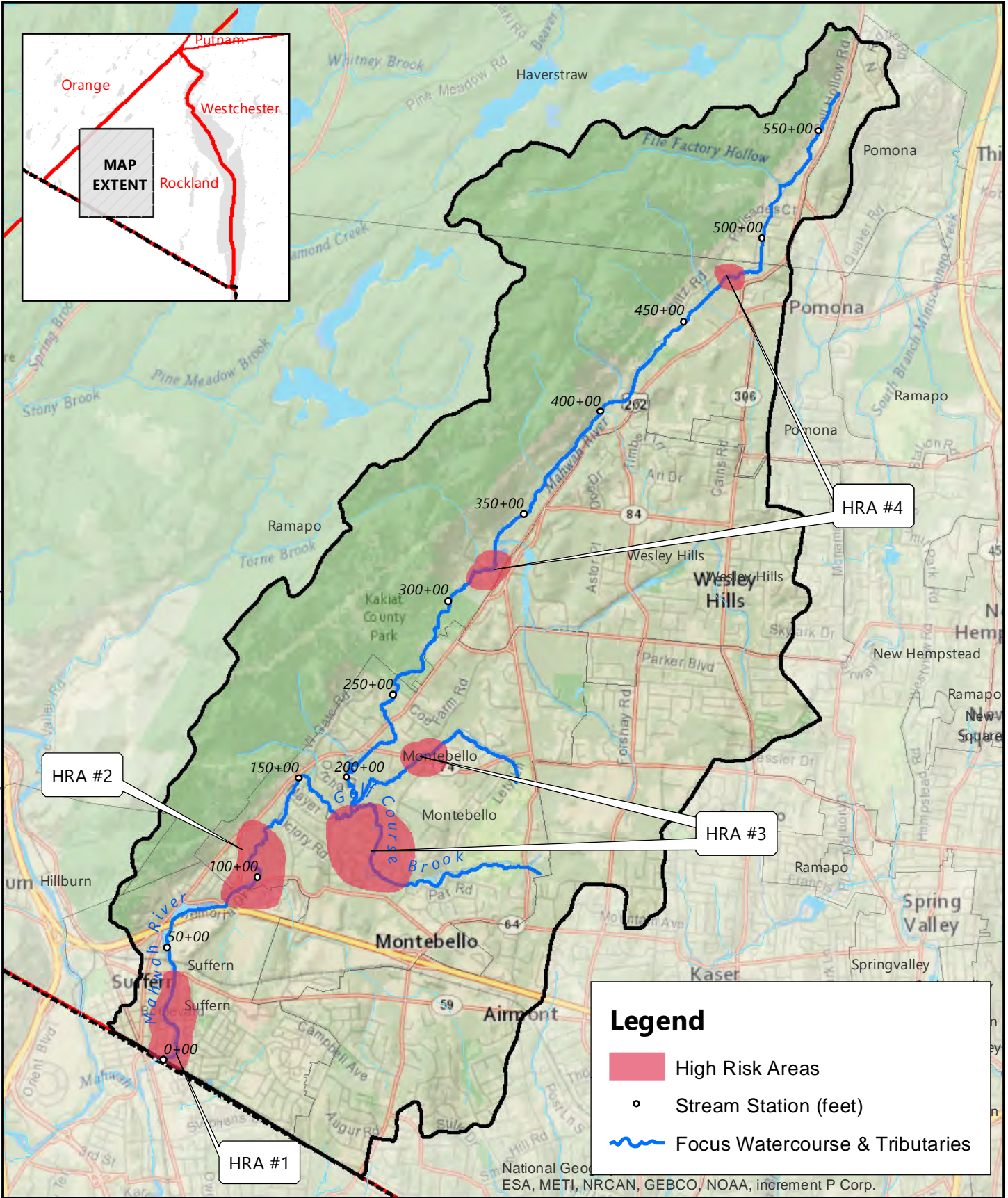
FEMA FLOOD INSURANCE MAP
 MAHWAH RIVER FLOOD & RESILIENCY STUDY
 SD111
 ROCKLAND COUNTY
 NEW YORK

SCALE 1" = 5,000'
 DATE 9/9/2021
 PROJ. NO. 16511.00006
FIG. 3-2



4. FLOOD MITIGATION ANALYSIS

In this section, flood-prone areas within the Mahwah River Watershed are identified, and an analysis of flood mitigation considerations within each HRA is undertaken. HRAs were identified based on a variety of sources including comments received during stakeholder meetings; conversations with municipal officials, emergency responders, landowners, and business owners; and through review of FEMA FISs and FIRMs, 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 HRAs within the Mahwah River watershed.



Legend

- High Risk Areas
- Stream Station (feet)
- Focus Watercourse & Tributaries

SLR

231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HIGH RISK AREAS

MAHWAH RIVER FLOOD & RESILIENCY STUDY
SD111
ROCKLAND COUNTY
NEW YORK

N

0 2,500 5,000
Feet

SCALE 1" = 5,000'

DATE 8/18/2021

PROJ. NO. 16511.00006

FIG. 4-1

4.1 HIGH RISK AREA #1

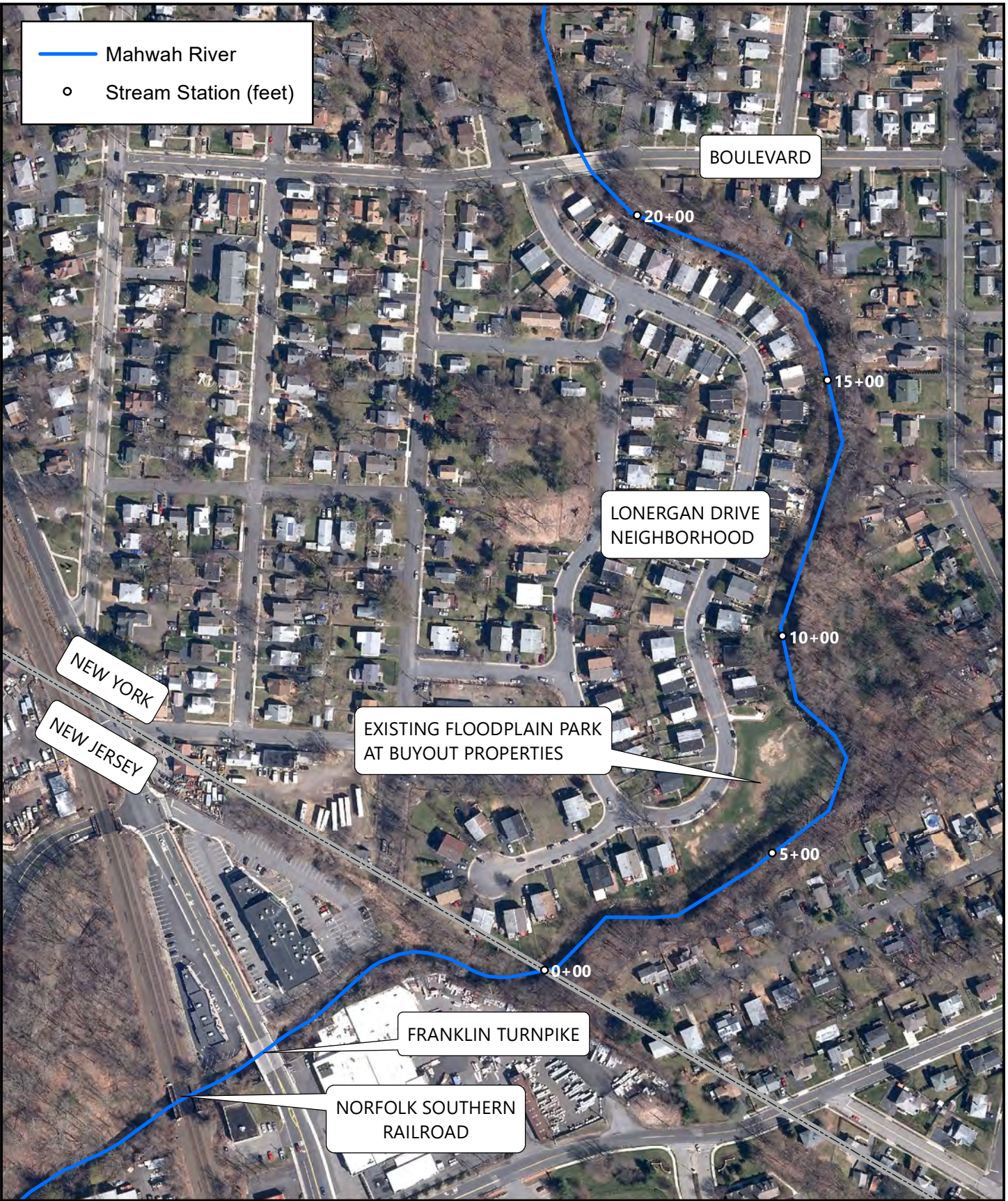
HRA 1 includes the Lonergan Drive neighborhood in Suffern, located on the right bank of the Mahwah River just upstream of the New York/New Jersey State Line (Figure 4-2). Watershed size at this location measures 21.2 square miles.

Effective FEMA modeling of the Mahwah River in New Jersey was completed in 2013 as part of the Bergen County, New Jersey, FIS (34003CV001B). This HEC-RAS model extends from the New York state line to the Mahwah's confluence with the Ramapo River, approximately 3,500 feet downstream. The model was obtained from NYSDEC and subsequently extended 2,200 feet upstream into New York to the Boulevard Bridge crossing. This corresponds to river station (STA) 0+00 to STA 22+00 measured from the state line. Five additional cross sections were added based on LiDAR-derived topographic mapping of the overbanks and field measurements of the wetted channel.

The Franklin Turnpike in New Jersey crosses the Mahwah River with a concrete arch bridge (National Bridge Inventory [NBI] Bridge Identification Number [BIN]: 020033B, pictured in Figure 4-3) about 500 feet downstream of the state line, followed by a riveted steel bridge for the Norfolk Southern Railroad (pictured in Figure 4-4) another 180 feet downstream. There are no North Atlantic Aquatic Connectivity Collaborative (NAACC) fish passage assessment reports for the structures in HRA 1. As it flows along Lonergan Drive in New York and under these bridges in New Jersey, the Mahwah River is confined on its left bank but has a relatively accessible floodplain on its right overbank. However, longitudinal floodplain flow is restricted by the railroad embankment, which is between 10 and 12 feet high as it runs across the roughly 650-foot-wide river valley. The entire floodplain is effectively dammed by the embankment except for a roughly 30-foot opening at the far right end of the valley where it is penetrated by US-202.

The Franklin Turnpike bridge, and railroad bridge and embankment, were removed from the model individually and in combination to assess their role in flooding of the Lonergan Drive neighborhood.

Modeling demonstrates that for floods that are generally contained in the river channel the Franklin Turnpike bridge is undersized and contributes to backwater flooding of the Lonergan area. For example, in the 10-year discharge, nearly 1 foot of additional backwater flooding is modeled upstream, which is enough to partially or completely inundate about a dozen multifamily homes that otherwise would not be affected. The railroad bridge causes comparable backwater flooding in this more frequent discharge, but as more flows spill onto the overbanks, the imposition of the railroad embankment causes considerably more severe backwater flooding. In the 100-year flood, the railroad bridge and embankment generate a 2-foot-deep backwater that extends about 2,700 feet upstream, reaching to within 400 feet of the Boulevard Bridge and contributing substantially to flooding of nearly the entire Lonergan neighborhood. In the modeled 500-year flood, the railroad bridge and embankment cause up to 2.9 feet of additional flood depths in the area. The 10-year and 100-year flood profiles under modeled scenarios are shown in Figures 4-5 and 4-6. Representative inundation mapping is presented in Figures 4-9, 4-10, and 4-11 (existing conditions under the 10-, 50-, and 100-year flood events, respectively); Figures 4-12, 4-13, and 4-14 (with the Franklin Turnpike bridge removed from the model under the 10-, 50-, and 100-year flood events, respectively); Figures 4-15, 4-16, and 4-17 (with the railroad bridge removed from the model under the 10-, 50-, and 100-year flood events, respectively); and Figures 4-18, 4-19, and 4-20 (with both the Franklin Turnpike bridge and the railroad bridge removed from the model under the 10-, 50-, and 100-year flood events, respectively).



— Mahwah River
 ○ Stream Station (feet)

BOULEVARD

20+00

15+00

LONERGAN DRIVE NEIGHBORHOOD

10+00

NEW YORK

NEW JERSEY

EXISTING FLOODPLAIN PARK AT BUYOUT PROPERTIES

5+00

0+00

FRANKLIN TURNPIKE

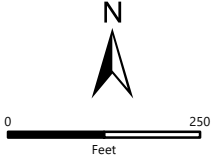
NORFOLK SOUTHERN RAILROAD



231 MAIN STREET
 SUITE 102
 NEW PALTZ, NY 12561
 845.633.8153

HIGH RISK AREA #1 - LONERGAN DR NEIGHBORHOOD

MAHWAH RIVER FLOOD & RESILIENCY STUDY
 SD111
 ROCKLAND COUNTY
 NEW YORK



SCALE 1" = 250'

DATE 9/8/2021

PROJ. NO. 16511.00006

FIG. 4-2



Figure 4-3: Franklin Turnpike crossing of the Mahwah River in New Jersey. View looking downstream.



Figure 4-4: Norfolk Southern Railroad crossing of the Mahwah River in New Jersey. View looking downstream.

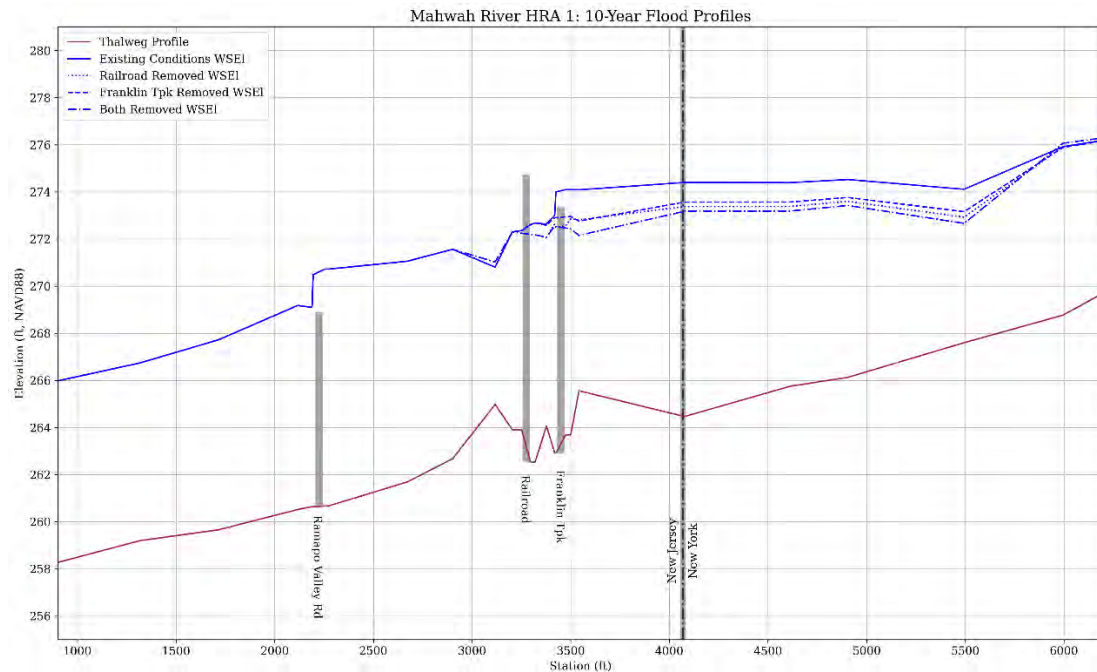


Figure 4-5: Modeled 10-year flood profiles under existing conditions and with the Railroad and Franklin Turnpike bridges removed individually and in combination. Both structures cause comparable increases in flooding at the Lonergan Drive neighborhood in this more frequent event.

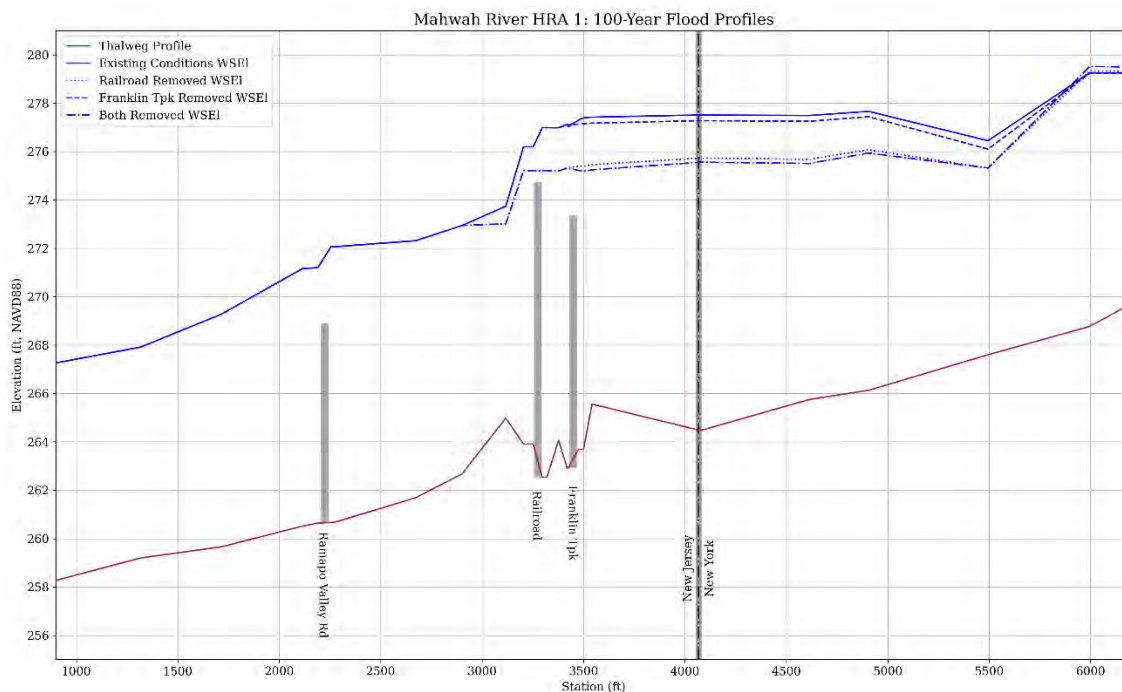


Figure 4-6: Modeled 100-year flood profiles under existing conditions and with the Railroad and Franklin Turnpike bridges removed individually and in combination. The railroad causes the majority of the increased flooding at the Lonergan Drive neighborhood in this more severe event.

As of 2019, NYS Department of Homeland Security and Emergency Services (DHSES) records indicate that 23 properties on Lonergan Drive, Temple Lane, and Ruby Street have incurred repetitive or severe repetitive losses due to flooding. This represents more than half of all such properties in the village of Suffern.

Projected future flows scenarios were also modeled on this reach of Mahwah River, with 11 percent and 12 percent added to the current 100- and 50-year flood discharge estimates, respectively; these values were gleaned from the USGS Future Flows Explorer for New York at this location and applied to the flows developed for the Bergen County, New Jersey, FIS. The more conservative New York State Department of Transportation (NYSDOT) hydraulic design standard of a 20 percent increase over current estimates, and the New Jersey Flood Hazard Area Design Flood, which is equal to the 100-year discharge plus 25 percent (not to exceed the 500-year magnitude), were modeled as well. Shown in profile in Figure 4-7, these greater discharges result in fairly uniform increases in BFE throughout the affected parts of the Lonergan Drive neighborhood under existing conditions, ranging from between 0.4 feet and 1.0 feet depending on the scenario. Proposed conditions modeling demonstrates that the benefits of alleviating the downstream hydraulic constrictions grow along with increases in discharge magnitude.

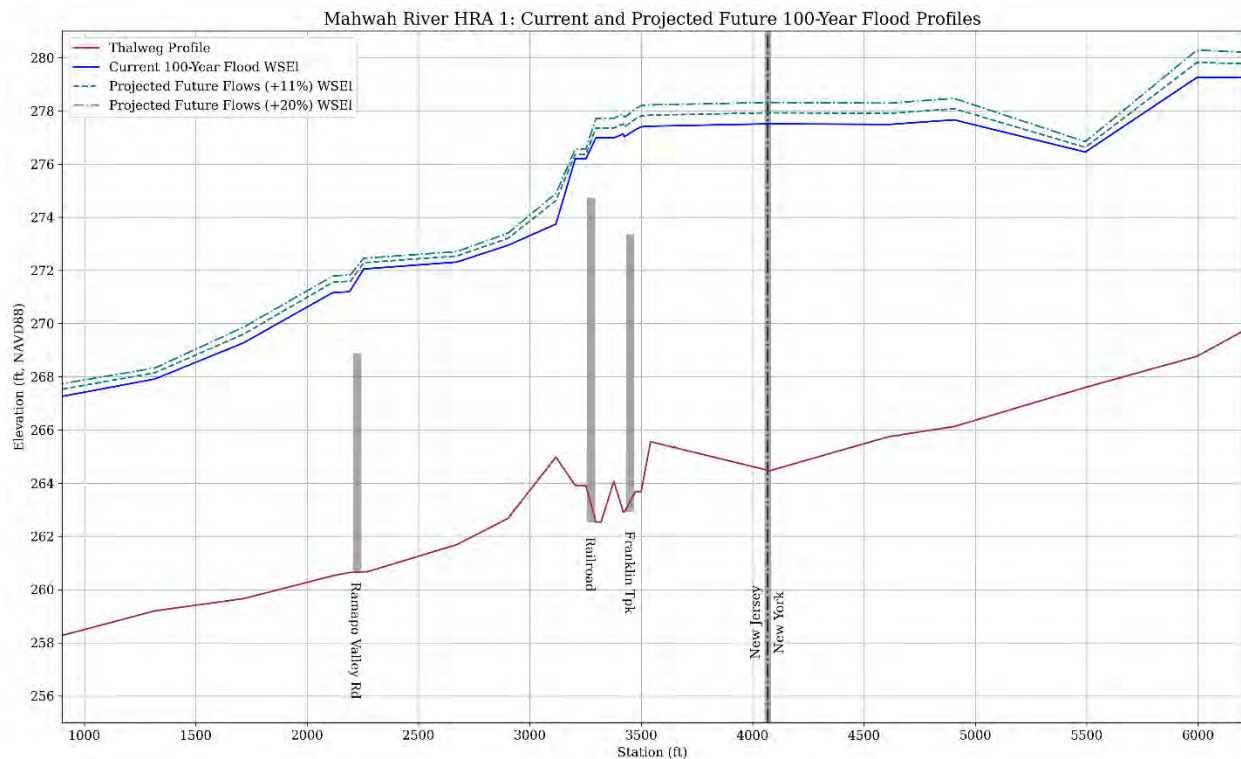


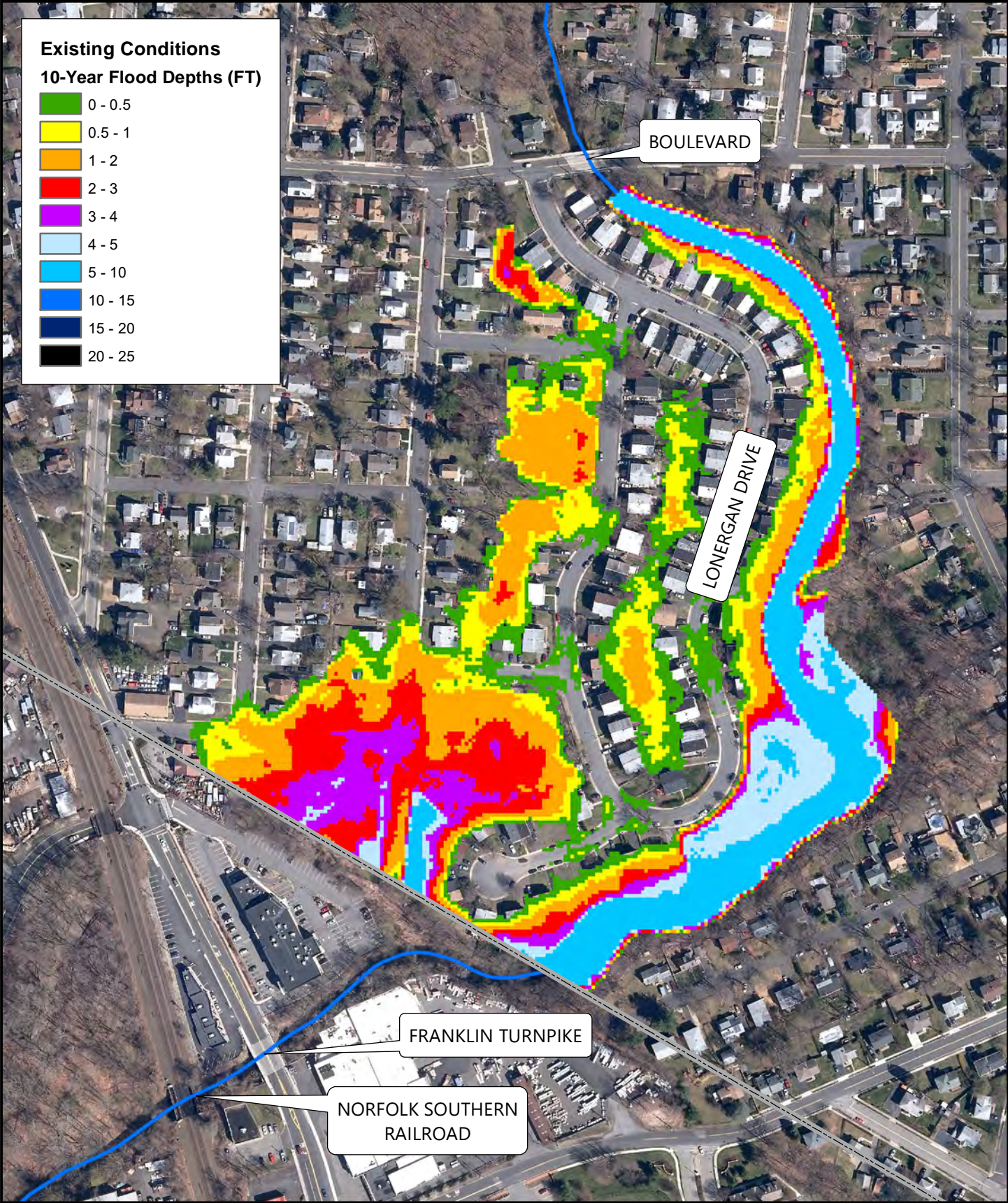
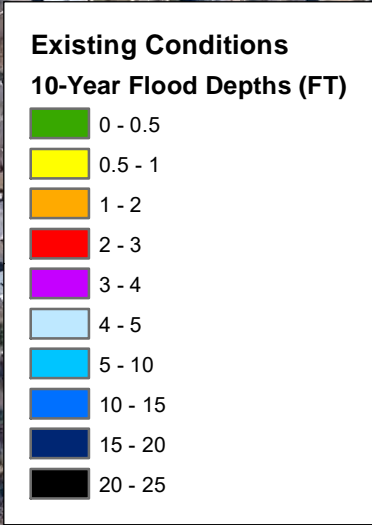
Figure 4-7: Modeled Projected Future 100-Year Flood Profiles under Existing Conditions



Figure 4-8: Flood stage indicator on the north side of the Franklin Turnpike on Mahwah River's right overbank. In the 100-year flood, depths of nearly 7 feet are modeled at this location under existing conditions.



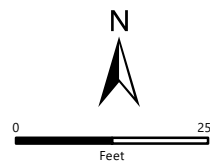
Figure 4-8A: US-202 underpass at Norfolk Southern Railroad, 550 feet north of the Mahwah River, during Tropical Storm Irene in 2011. Floodwaters are several feet deep on the roadway. Business park shown in Figure 4-8 is visible in background.



231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HIGH RISK AREA #1 - LONERGAN DR NEIGHBORHOOD

MAHWAH RIVER FLOOD & RESILIENCY STUDY
SD111
ROCKLAND COUNTY
NEW YORK

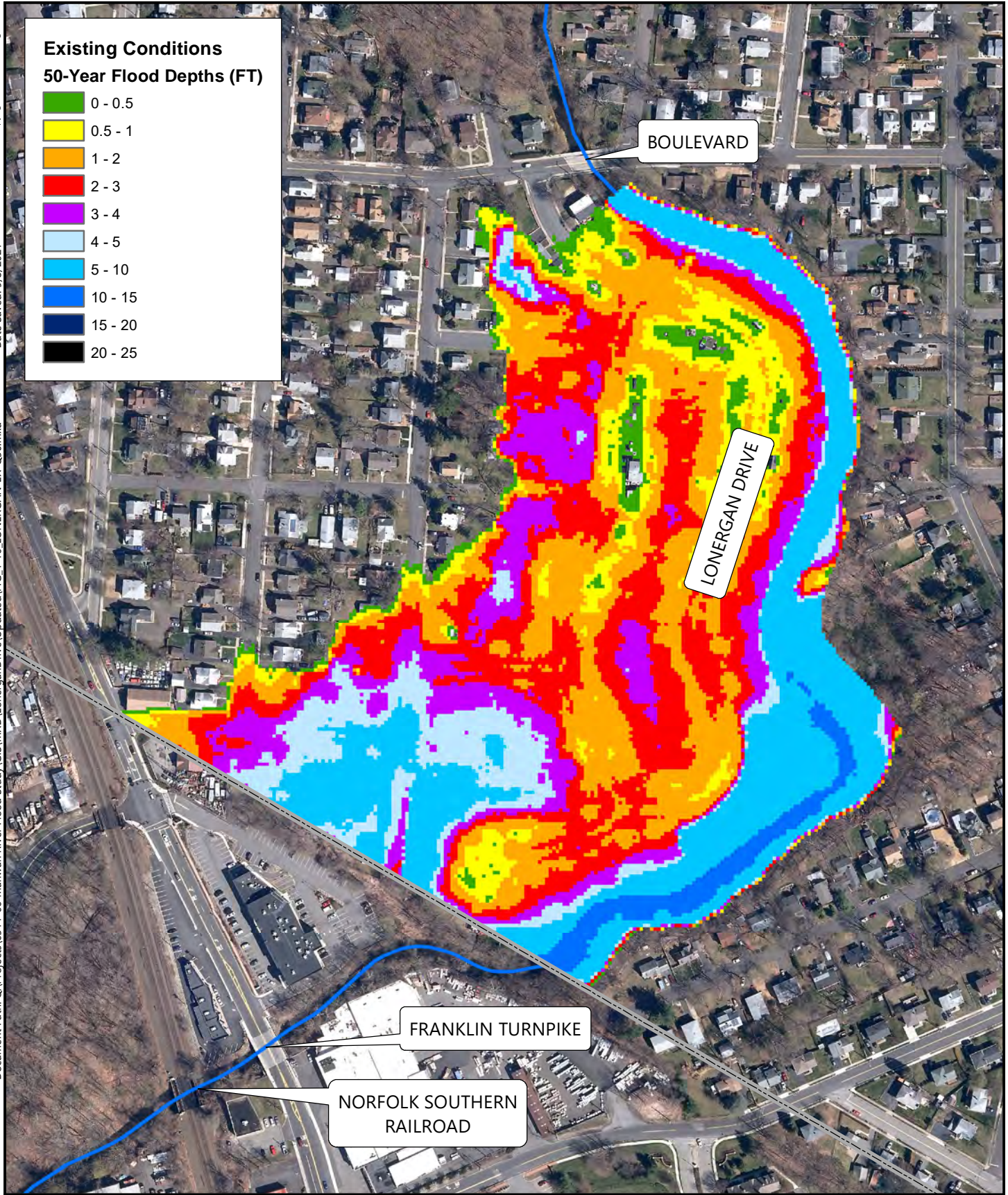
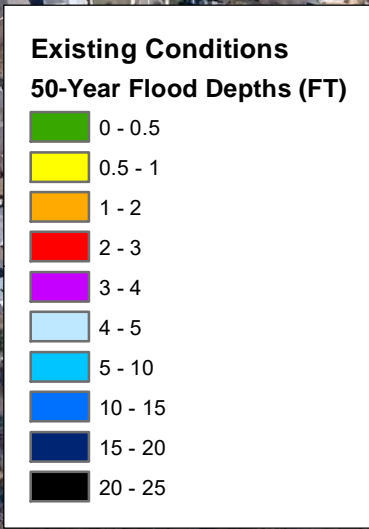


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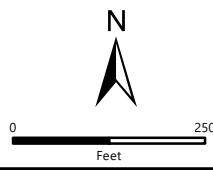
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FIG. 4-9



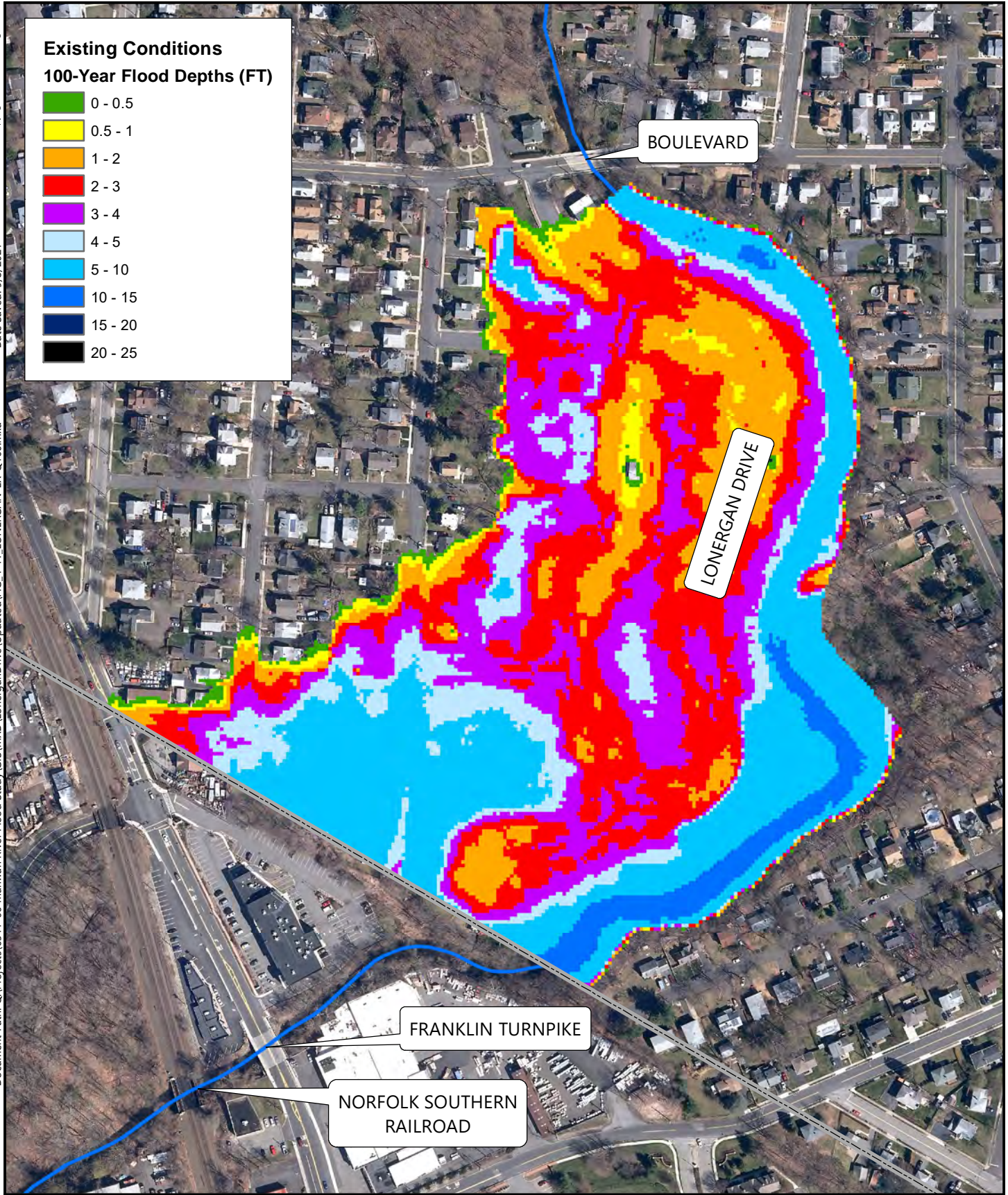
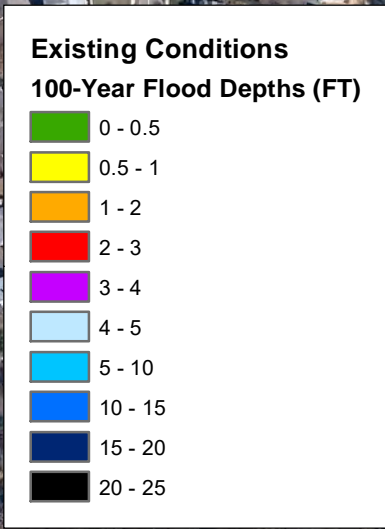
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HIGH RISK AREA #1 - LONERGAN DR NEIGHBORHOOD
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 ROCKLAND COUNTY
 NEW YORK



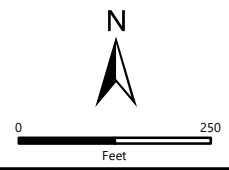
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FIG. 4-10



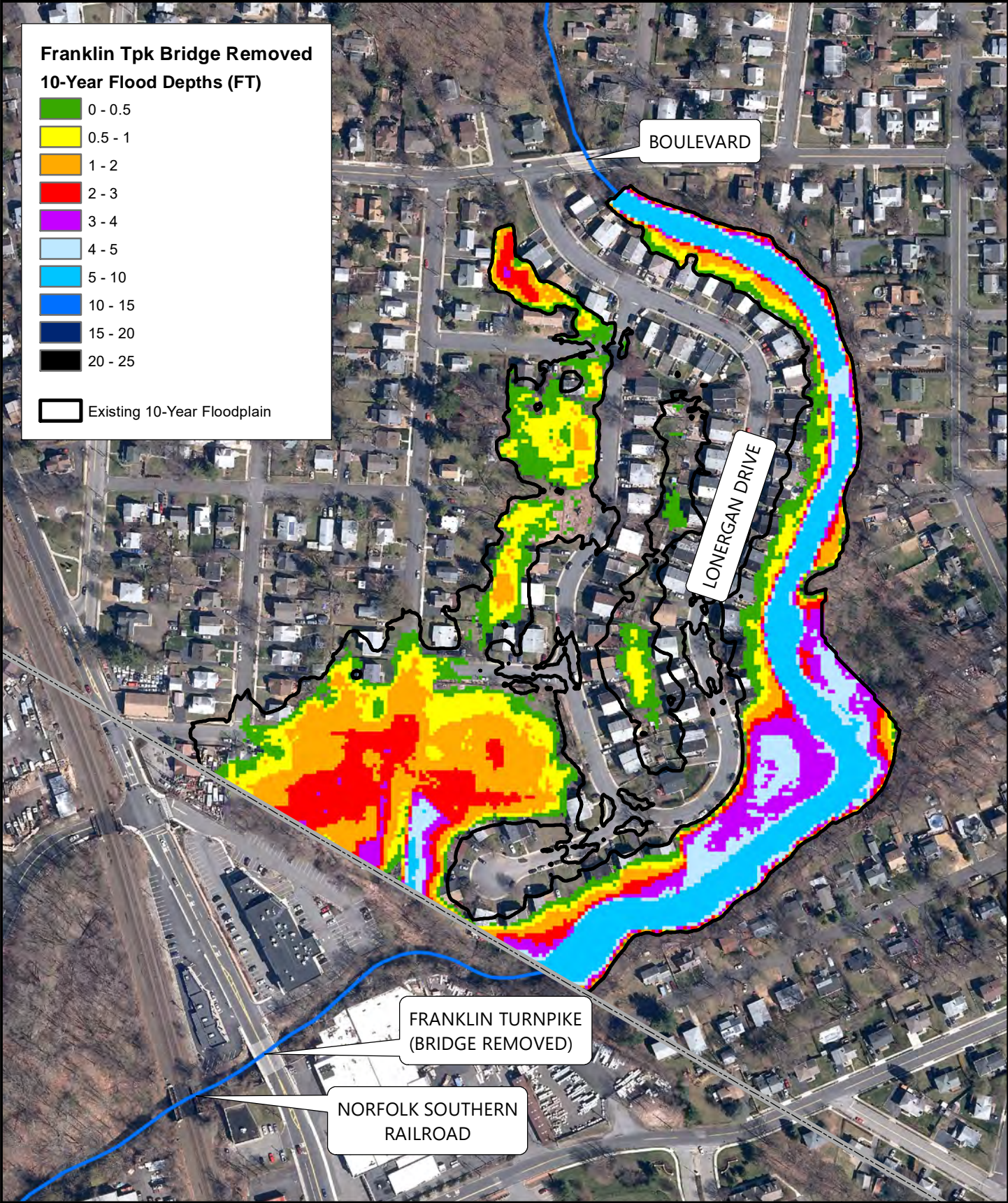
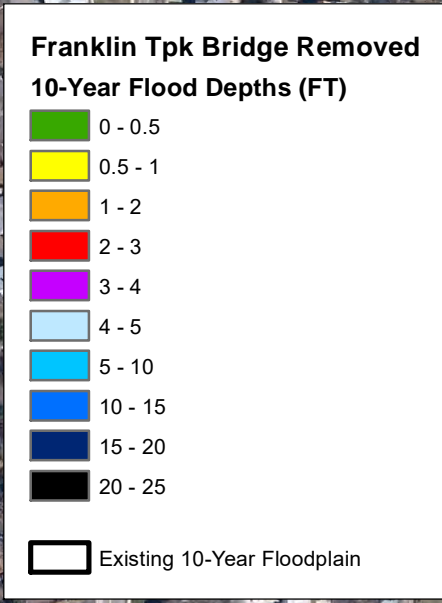
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FIG. 4-11



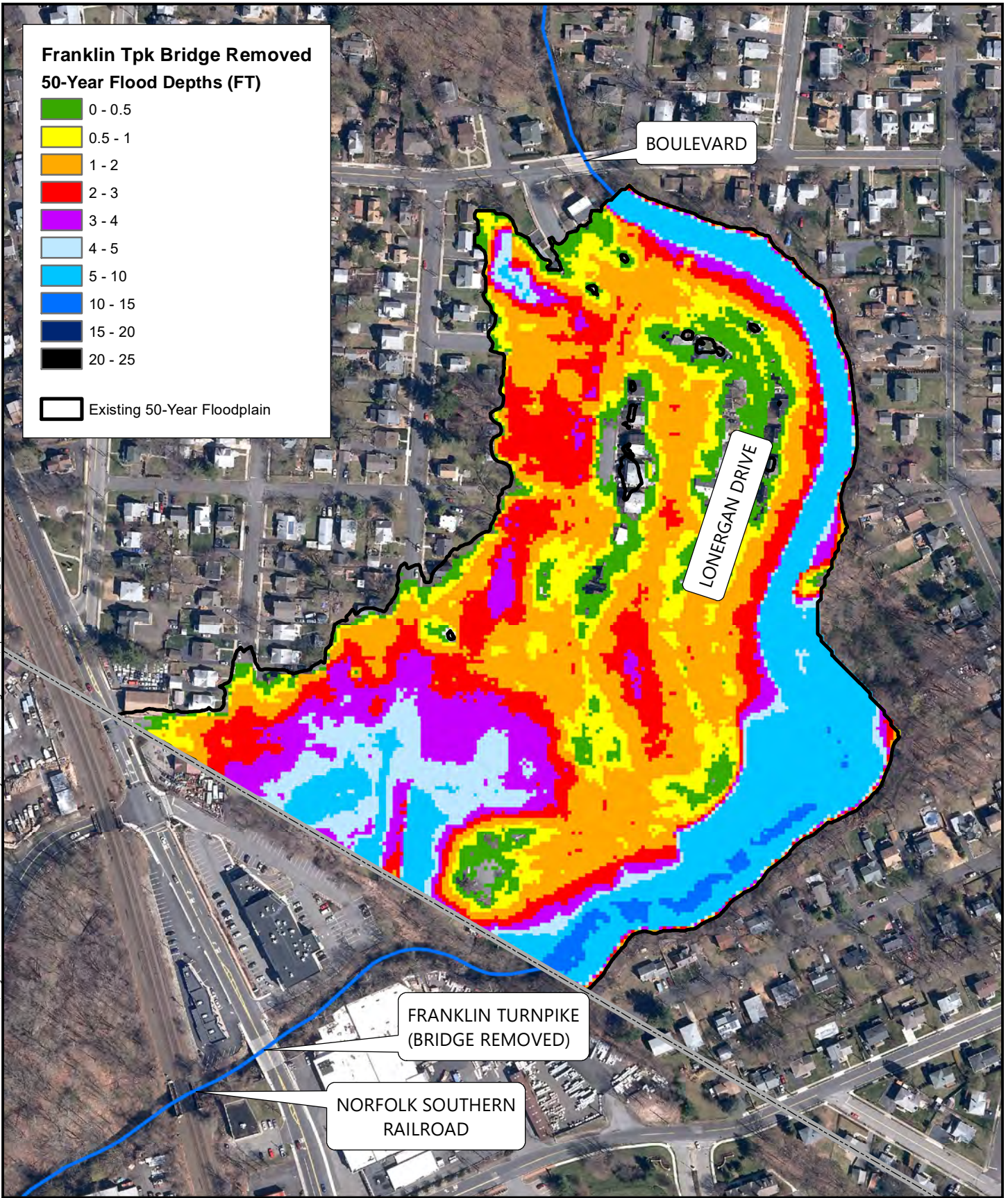
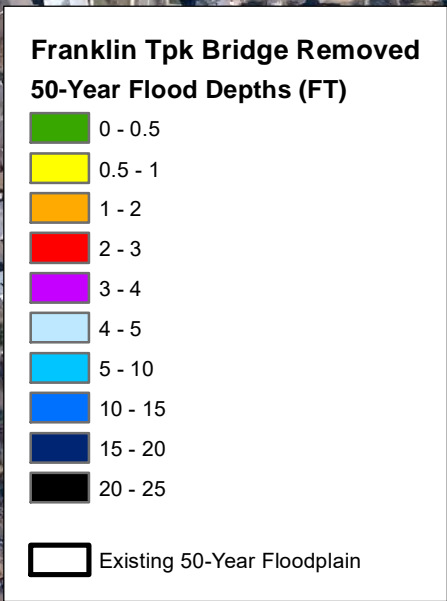
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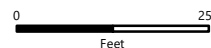
FIG. 4-12



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HIGH RISK AREA #1 - LONERGAN DR NEIGHBORHOOD

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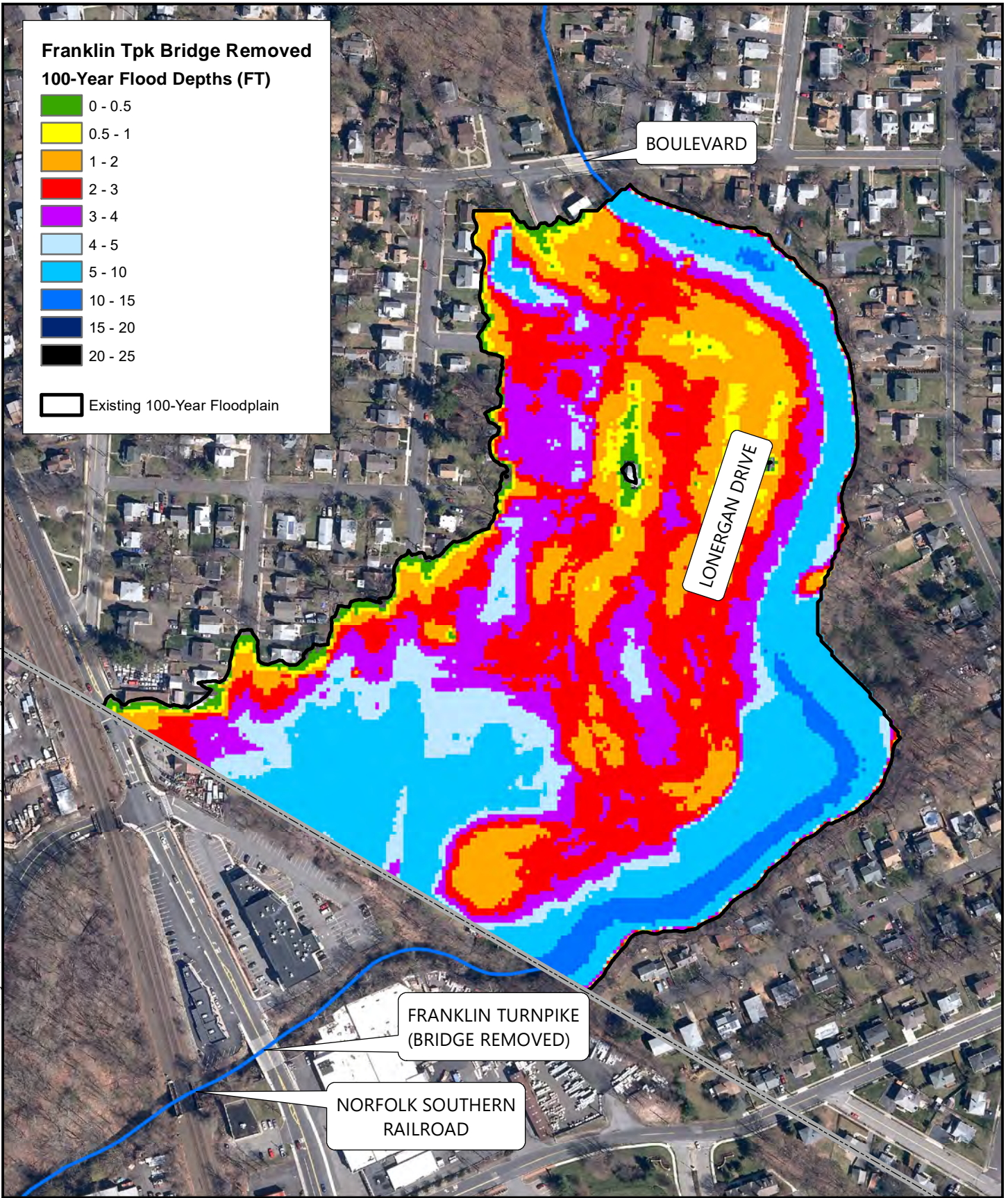
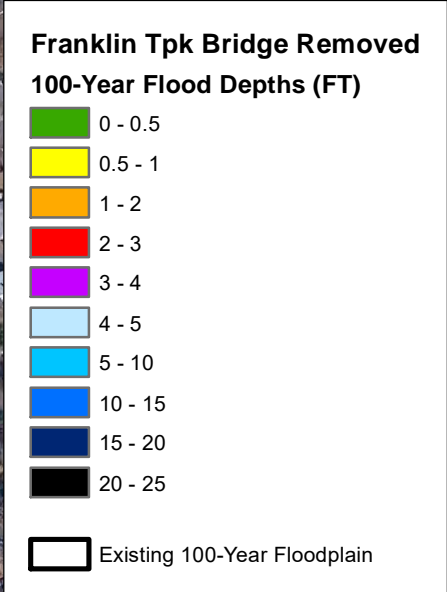


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FIG. 4-13



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HIGH RISK AREA #1 - LONERGAN DR NEIGHBORHOOD

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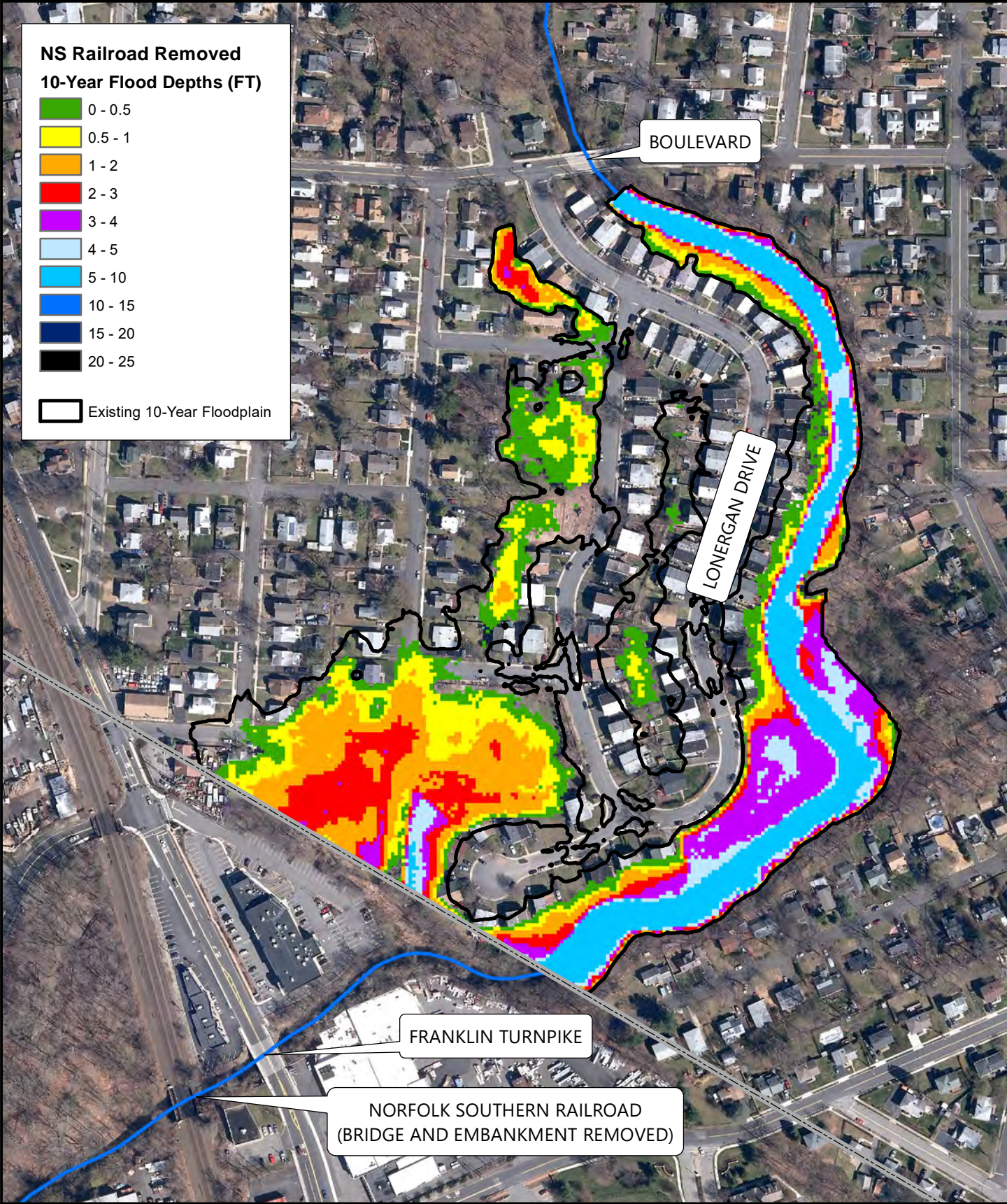
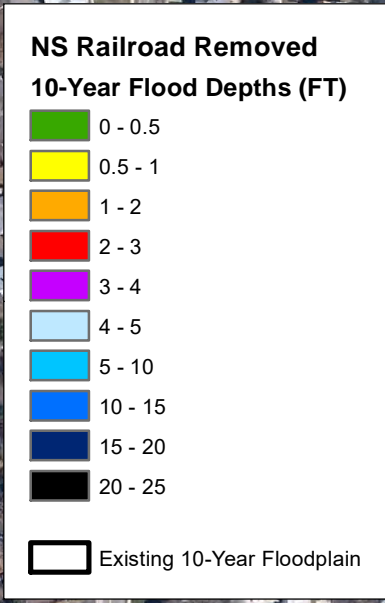


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FIG. 4-14



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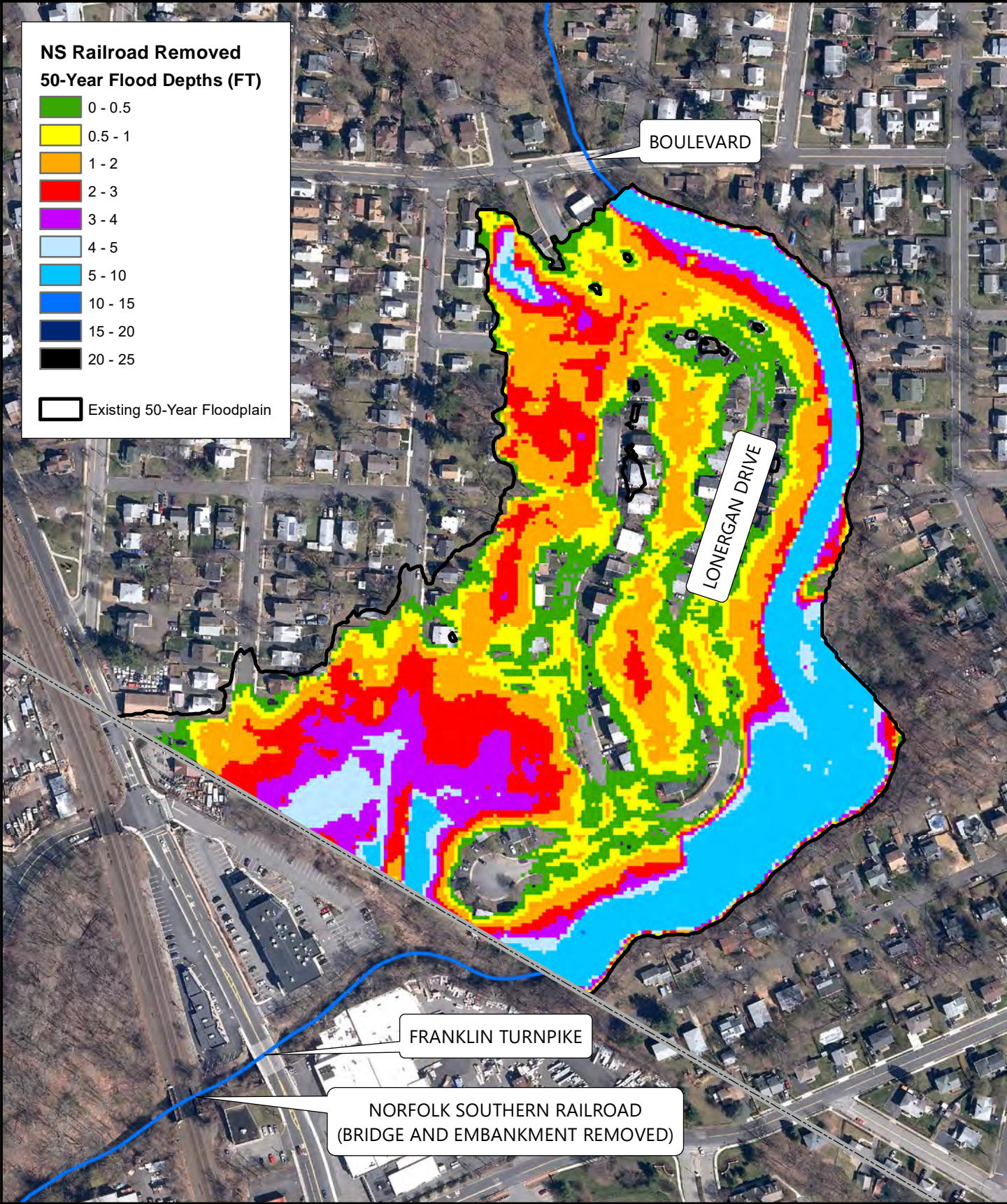
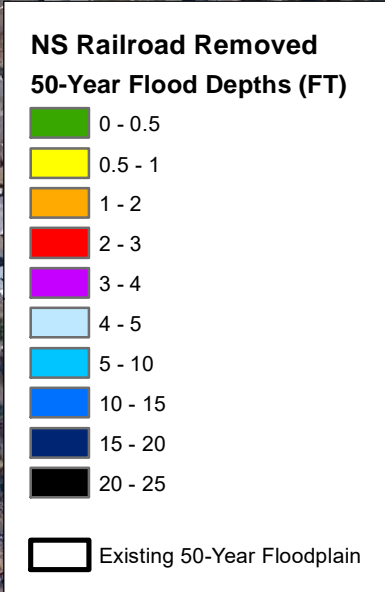


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FIG. 4-15



FRANKLIN TURNPIKE

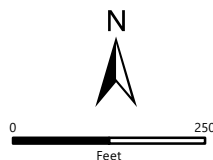
NORFOLK SOUTHERN RAILROAD
(BRIDGE AND EMBANKMENT REMOVED)



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HIGH RISK AREA #1 - LONERAGAN DR NEIGHBORHOOD

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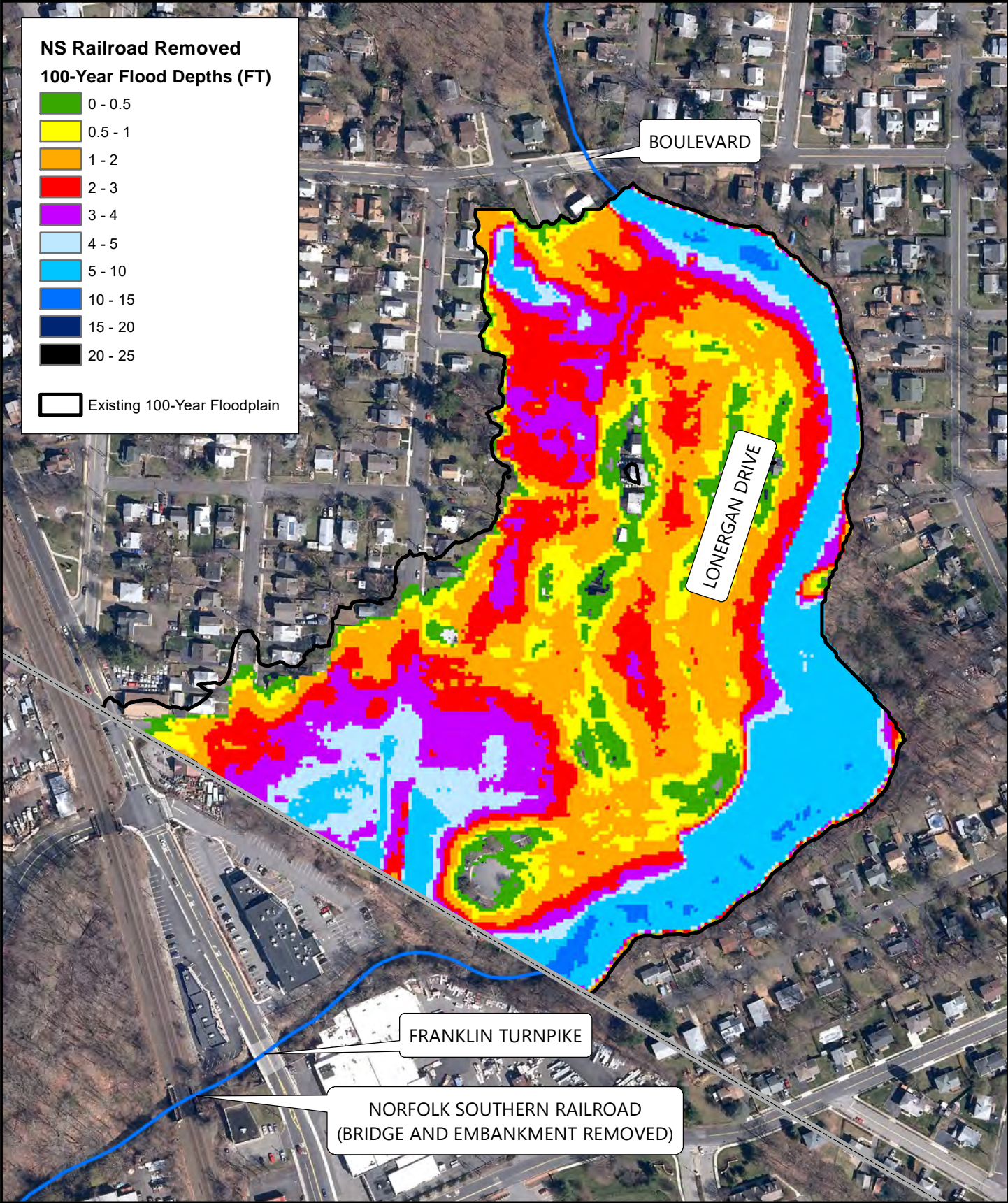
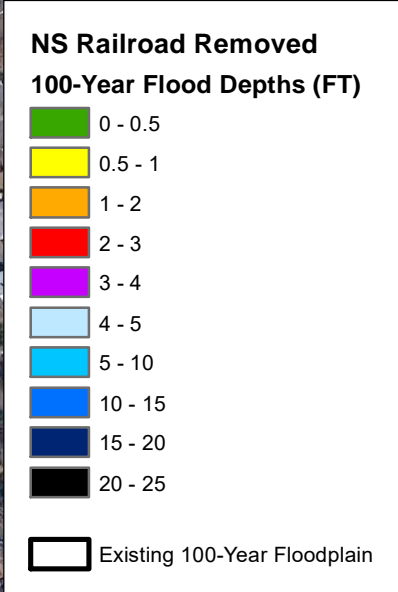


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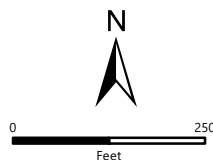
FIG. 4-16



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HIGH RISK AREA #1 - LONERGAN DR NEIGHBORHOOD

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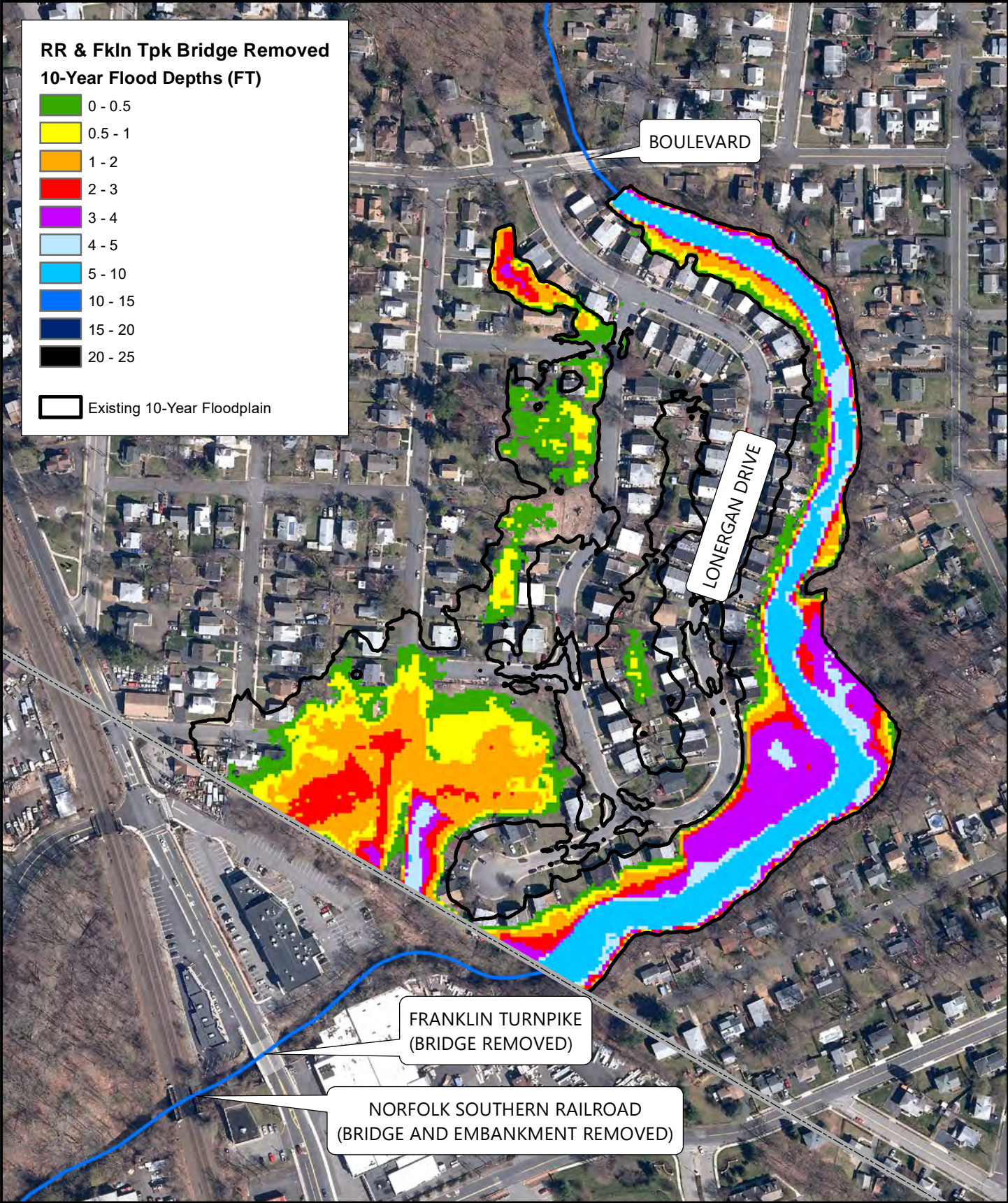
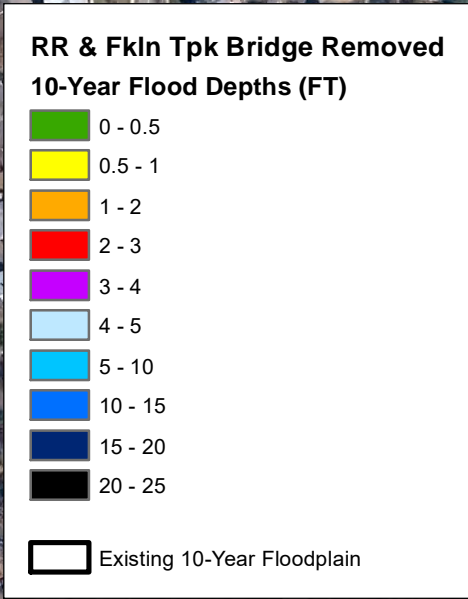


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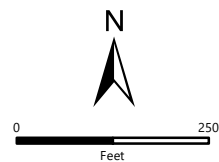
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FIG. 4-17



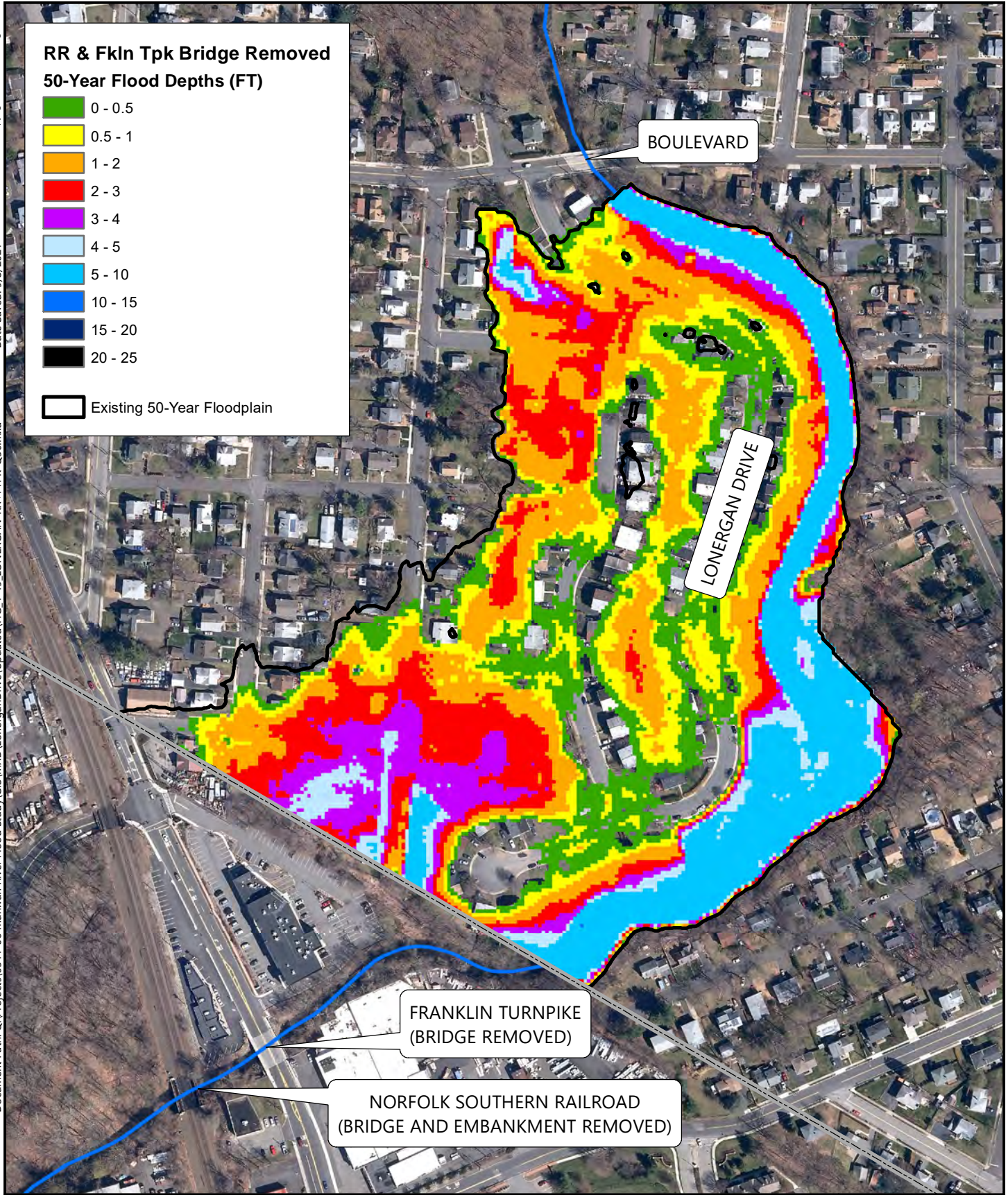
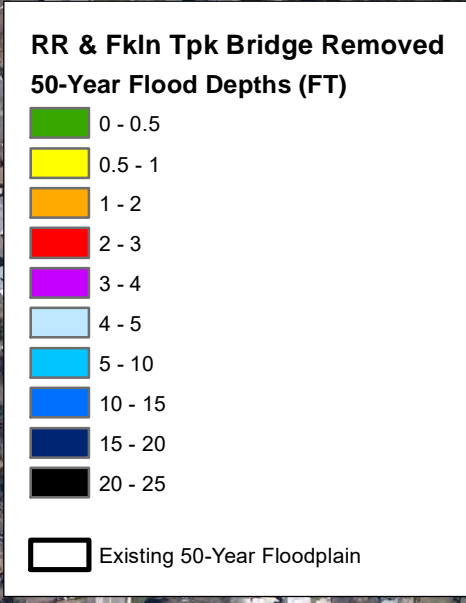
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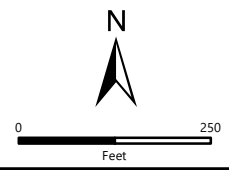
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FIG. 4-18



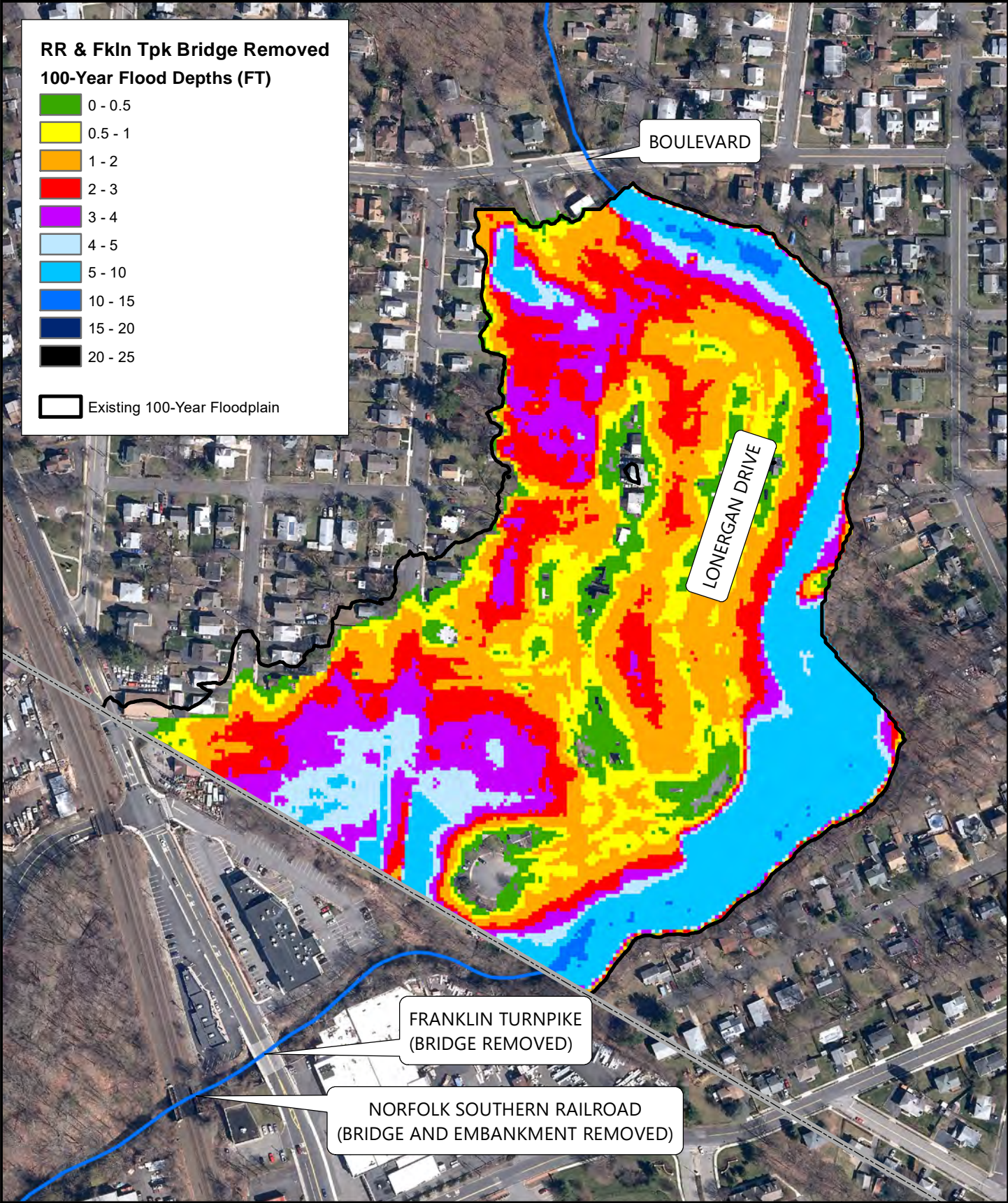
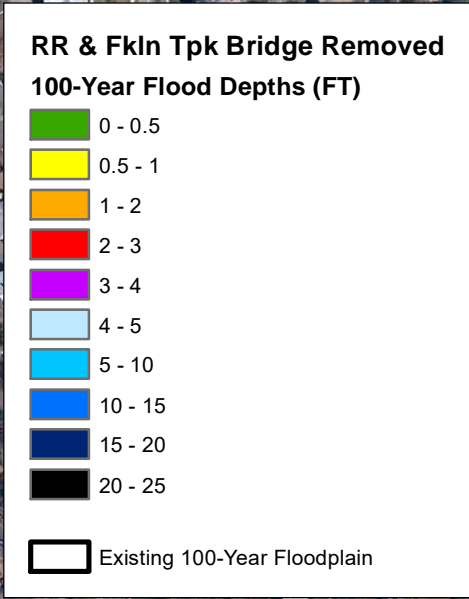
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HIGH RISK AREA #1 - LONERGAN DR NEIGHBORHOOD
 MAHWAH RIVER FLOOD & RESILIENCY STUDY
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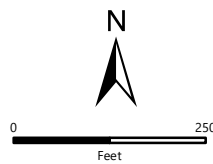
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FIG. 4-19



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HIGH RISK AREA #1 - LONERGAN DR NEIGHBORHOOD
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SCALE 1" = 250'
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FIG. 4-20

Floodplain benching along the Mahwah River on the east side of Loneragan Drive was modeled both with and without the tailwater influence of the Franklin Turnpike and Norfolk Southern Railroad crossings. This results in reductions of flooding depths upstream of the direct tailwater influence of the downstream constrictions by between about 0.5 feet and 1.0 feet, depending on the scenario and flood magnitude. Reductions in flood elevations increase along with discharge; in the current 100-year flood, this floodplain bench reduces depths in the upper reaches of the Loneragan Drive neighborhood by about 0.8 feet and by about 1.0 feet in the projected future 100-year flood. Further reduction by about 0.6 feet is modeled in both current and future scenarios when the Franklin Turnpike and Norfolk Southern Railroad bridge backwaters are eliminated. This alternative requires removal of 20 flood-prone multifamily homes to facilitate an 80-foot-wide floodplain bench that reduces flooding elsewhere in the neighborhood. Several buildings have already been removed between Loneragan Drive and the Mahwah River farther downstream in the neighborhood. This area is currently a floodplain park, which could presumably be expanded along with any further buyouts. At its full extent, the proposed floodplain would cover approximately 2.3 acres and require between about 2 and 4 feet of elevation reduction along this roughly 1,250 linear feet of the Mahwah River to remove approximately 12,000 cubic yards of material. A conceptual layout of the floodplain bench is depicted in Figure 4-21.

In more frequent flood events that are generally confined to the Mahwah River's channel, immediate overbanks, and more accessible floodplains, the hydraulic constriction of the Franklin Turnpike bridge in New Jersey can exacerbate flooding in the Loneragan Drive neighborhood. This amounts to roughly an additional 1 foot of floodwater depths in the modeled 10-year and 25-year floods. The structure's influence diminishes as additional floodplain conveyance becomes available in the more extreme flood events, like the 50-year and 100-year discharges, which is essentially uninhibited by the Franklin Turnpike approach roadway on the right overbank. When it is due for replacement, detailed hydrologic and hydraulic analyses are recommended to inform an adequately sized crossing that will reduce backwater flooding.

The Norfolk Southern Railroad bridge constriction has an influence on upstream flooding as well, but its approach embankment causes the more severe impacts because it effectively dams nearly the entire floodplain, with only the US-202 underpass for relief (Figure 4-8A). Modeling shows that this causes substantial increases in flooding depths in the Loneragan Drive neighborhood upstream than would occur otherwise, between up to 1 foot and nearly 2 feet in the 10-year and 100-year floods, respectively. Further detailed hydrologic and hydraulic analyses are recommended to facilitate provision of significant floodplain relief capacity through the embankment and alleviate flooding of the upstream neighborhoods and businesses in New York and New Jersey. Retrofitting the railroad crossing by perforating the embankment with 20 6-foot-diameter corrugated metal pipe (CMP) culverts between the Mahwah River and the US-202 underpass was simulated; this provides up to about 0.3 feet of reduction in upstream BFE and about 0.6 feet of reduction of projected future 100-year flood depths. This configuration was also modeled with 20 10-foot-span, 6-foot-rise concrete box culverts, which results in reduction of current and future 100-year upstream flood depths by about 0.4 feet and 0.8 feet, respectively. Given the relatively limited benefits associated with these relief culverts, such a retrofitting may not be as practical as a complete reconfiguration of the crossing but may be an acceptable interim solution.



- Mahwah River
- Stream Station (feet)
- Proposed Floodplain Park

PROPOSED EXPANDED FLOODPLAIN PARK AREA
ALONG WITH ANY FUTURE VOLUNTARY BUYOUTS

EXISTING FLOODPLAIN PARK
AT BUYOUT PROPERTIES

NORFOLK SOUTHERN RAILROAD
PROPOSED INCREASED FLOODPLAIN RELIEF

FRANKLIN TURNPIKE
PROPOSED INCREASED BRIDGE SPAN

NORFOLK SOUTHERN RAILROAD
PROPOSED INCREASED BRIDGE SPAN

NEW YORK
NEW JERSEY

BOULEVARD

20+00

15+00

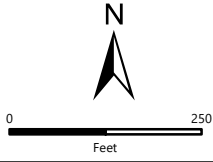
10+00

5+00

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HIGH RISK AREA #1 - LONERGAN DRIVE CONCEPT MAP
MAHWAH RIVER FLOOD & RESILIENCY STUDY
SD111
ROCKLAND COUNTY
NEW YORK



SCALE 1" = 250'
DATE 9/8/2021
PROJ. NO. 16511.00006

FIG. 4-21

Hydraulic modeling and a review of regional regression equations indicate that a minimum bridge span of approximately 75 feet is required at both the Franklin Turnpike bridge and the Norfolk Southern Railroad bridge. However, in the case of the railroad, the approach embankment is a substantial barrier to longitudinal overbank flow, so additional floodplain conveyance under the railway is necessary to reduce upstream flooding in addition to the increased bridge span.

If voluntary buyouts of flood-prone homes continue between Lonergan Drive and the Mahwah River, floodplain benching is recommended, as practical. This can help alleviate flooding in other parts of the neighborhood that are not immediately adjacent to the river. These benefits would currently be limited to the areas upstream of the direct influence of the backwaters from the downstream crossings.

4.2 HIGH RISK AREA #2

HRA 2 includes the Montebello Road bridge crossing of the Mahwah River at STA 92+00 and the Lake Road area in the village of Montebello (Figure 4-22). The Montebello Bridge has the NAACC crossing code *xy4112401074136227*, but an assessment for aquatic organism passage has not been completed at the time of this report. The watershed of the Mahwah River at this location is 19.6 square miles. The area was severely flooded during Tropical Storm Irene, and the Montebello Road bridge was overtopped by floodwaters (Figure 4-23). FEMA-funded buyouts and demolitions of several residential properties have reportedly occurred since the Tropical Storm Irene flood in 2011. FEMA FIRMs indicate that Lake Road, Marian Drive, and Montebello Road have been mapped within the 100-year flood zone. As of 2019, NYS DHSES records indicate that five properties on Marian Drive and Lake Road have incurred repetitive or severe repetitive losses due to flooding. Built in 1936, the Montebello Road bridge (NBI BIN: 3346120) was substantially damaged during Tropical Storm Irene in 2011 and rehabilitated by Rockland County in 2015.



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HIGH RISK AREA #2 - MONTEBELLO ROAD

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 SD111
 ROCKLAND COUNTY
 NEW YORK

SCALE 1" = 250'

DATE 9/8/2021

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FIG. 4-22



Figure 4-23 Montebello Road Bridge during Tropical Storm Irene. Photo courtesy of Rockland County.

FEMA hydraulic modeling for the Mahwah River in the area of HRA 2 is based on an antiquated HEC-2 analysis dating from the 1980s. Profiles derived from the HEC-2 model and published in the FEMA FIS for Rockland County indicate that the Montebello Road bridge acts as a hydraulic constriction resulting in increased water surface elevations upstream of the bridge, including sections of Lake Road, Marian Drive, and Montebello Road. The profiles also indicate that the bridge deck is close to overtopping during the 100-year flood event and is overtopped during the 500-year flood event. When the Montebello Road bridge was rehabilitated in 2015, it was reportedly constructed with the same or similar hydraulic opening size as the previous bridge. Therefore, it is assumed that the FEMA modeling is a reasonable representation of today's configuration of the Mahwah River at the Montebello Road bridge.

Based on an assessment using regional regression equations developed for the State of New York to determine bankfull channel characteristics (Mulvihill, et al., 2010) and a visual inspection of the river in the vicinity of the bridge, the Mahwah River has a bankfull width of approximately 57 feet as it flows through HRA 2 and under the Montebello Road bridge. As a general guideline to evaluate the adequacy of the hydraulic opening, NYSDEC Stream Crossing Guidelines state that a bridge span should be at least 1.25 times the width of the stream channel bed. The Montebello Road bridge has an abutment-to-abutment span of 47.5 feet, or approximately 83 percent of the channel's bankfull width.

Based on analysis of the FEMA hydraulic model profiles, field assessment, and comparison of the bridge span to the channel's bankfull width, it can be concluded that the Montebello Road bridge is hydraulically undersized and contributes to flooding of areas of Lake Road, Marian Drive, and Montebello Road. Because the Montebello Road bridge was recently rehabilitated, it would not be practical or cost effective to replace it with a new bridge with a larger span until the bridge is due for replacement due to age or structural instability.

It may be feasible to install one or more floodplain relief culverts set adjacent to the Montebello Road bridge. These culverts would serve to add hydraulic capacity to the current bridge opening and would potentially act to reduce the extent and depth of flooding of Lake Road, Marian Drive, and Montebello Road during the less severe flood events that would not otherwise overwhelm the bridge. The existing bridge has a 47.5-foot span, with approach embankments encroaching on the roughly 100-foot-wide alluvial valley. If compatible with the bridge's structural design, installation of an additional 20-foot span on the right overbank is recommended, along with a 6-foot-diameter culvert on the left overbank. If larger structures are feasible, or if smaller structures are necessary, the largest practical relief provisions are recommended.

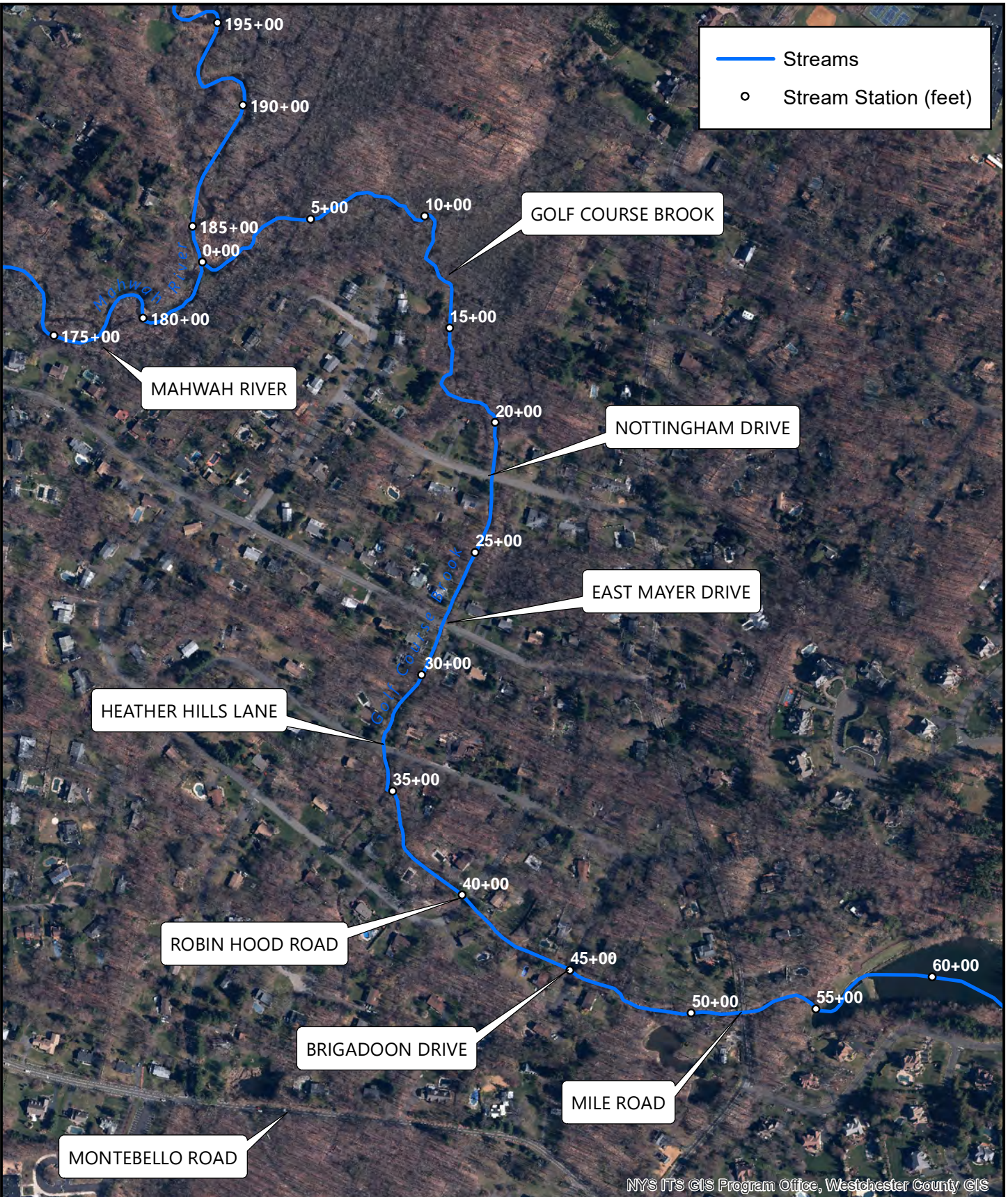
If the Montebello Road bridge were to be slated for replacement or fitted with relief culverts, a rigorous hydraulic analysis should be conducted to determine appropriate hydraulic sizing as a component of the project design. The hydraulic analysis should consider current and projected future flow events.

4.3 HIGH RISK AREA #3

HRA 3 includes two first-order tributaries to the Mahwah River, both located in the village of Montebello. Numerous crossings that span these tributaries are reportedly prone to frequent flooding. The first tributary is Golf Course Brook, which flows westward across Spook Rock Golf Course and Kathryn Gorman Ponds Park before turning northward through a residential neighborhood where it passes through six road crossings. The second tributary is unnamed and flows northward from Spook Rock Golf Course, through Spook Rock Pool Town Park, then turns westward and southwestward before passing under Viola Road.

Listed from downstream to upstream through these residential neighborhoods, Golf Course Brook passes under Nottingham Drive at STA 22+50, East Mayer Drive at STA 28+00, Heather Hills Lane at STA 33+50, Robin Hood Road at STA 40+00, Brigadoon Drive at STA 45+00, and Mile Road at STA 52+00. These culverts are not listed in the NBI. The watershed area of Golf Course Brook when measured at the Nottingham Drive crossing is 1.68 square miles. Golf Course Brook and the various stream crossings that were evaluated are depicted on Figure 4-24.

As of 2019, NYS DHSES records indicate that three properties along Golf Course Brook have incurred repetitive or severe repetitive losses due to flooding.



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HIGH RISK AREA #3 - GOLF COURSE BROOK
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 SD111
 ROCKLAND COUNTY
 NEW YORK

SCALE 1" = 500'
 DATE 9/8/2021
 PROJ. NO. 16511.00006

0 500
 Feet

FIG. 4-24

The FEMA FIS analysis is the most recently completed hydrologic analysis for Golf Course Brook; therefore, those computed peak flows were used for hydraulic analysis. The FEMA effective HEC-RAS model was used for the hydraulic analysis. Based on an analysis using regional regression equations (Mulvihill, et al., 2010) and field inspection, Golf Course Brook has a bankfull width of approximately 28 feet as it flows through these crossings. The crossings range in size from an 8-foot span at the Brigadoon Drive crossing to a 22-foot span at the Heather Hill Lane crossing.

Of the six crossings analyzed in the hydraulic model, under existing conditions only the Nottingham Drive crossing passes the 10-year flood event. The Mile Road crossing becomes flanked on the left (south) side during the 10-year flood event, and the other four crossings are overtopped during the 10-year flood event. The roadways at all six crossings become inundated during the 50-, 100-, and 500-year flow events. Under existing conditions, five houses located in close proximity to these crossings experience some level of flooding during the 10-year flood event, and 14 homes are flooded during the 50-year flood event.

According to NYSDEC Stream Crossing Guidelines, a stream crossing span should be at least 1.25 times the width of the stream channel bed. The hydraulic model was used to evaluate the six stream crossings if they were to be replaced with new structures with a span of 1.25 times the bankfull width, or approximately 34 feet. Under this scenario, reductions in flooding were observed at all crossings. Further expansion of the Nottingham Drive crossing to a 40-foot span and 6-foot height and the Heather Hill Lane crossing to 40-foot span and 4-foot height allowed for all structures to pass the 10-year future flow event. With these adjustments, four out of the six bridges in the study area also passed the 50-year future flood event. However, the Brigadoon Drive crossing would not have to be upsized to 34 feet to pass the 10-year and 50-year future flood events. Widening the crossing to a 20-foot span would be adequate to pass these flows. The results of the hydraulic analysis for the Golf Course Brook crossings are summarized in Table 4-1.

Under current flows and with the proposed structural changes, only one house would experience some level of flooding in the model during a 10-year flood event. The Mile Road bridge would experience flanking on Senator Levy Drive during a 10-year event. Heather Hill Lane would also experience some flooding. During a 50-year flood event, under proposed conditions, only two homes would experience flooding.

The stream gradient along the more downstream portion of Golf Course Brook is very flat, dropping only 4 feet from the Nottingham Drive crossing downstream to the confluence with the Mahwah River, a slope of less than 0.2 percent. This very flat gradient contributes to the extent of flooding in this downstream area and creates a backwater that reduces the hydraulic capacity of the upstream crossings including East Mayer Drive and Heather Hill Lane (See Figures 4-25 and 4-26). For this reason, any proposed project to increase the size of these crossings should begin at the downstreammost structure (Nottingham Drive) and proceed upstream.

**Table 4-1 Summary of Hydraulic Modeling Analysis
Golf Course Brook Crossings**

Golf Course Brook Crossing	Existing Structure	NAACC Crossing Code/ Aquatic Passability Score	Existing Flood Capacity	Modelled Replacement Structure	Replacement Structure Flood Capacity, Current Hydrology	Replacement Structure Flood Capacity, Projected Future Flows (RCP 4.5, 2050-2074)
Nottingham Drive	9' span x 4' rise Conc. Box Culvert	xy4112999374118498 / N/A <i>Yet to be Determined</i>	10-Year	40' Span Bridge	100-Year	50-Year
East Mayer Drive	9' span x 3.8' rise Conc. Box Culvert	xy4112816974118177 / 0.83 out of 1.0 <i>Insignificant Barrier</i>	<10-Year	34' Span Bridge	10-Year	10-Year
Heather Hill Lane	Two 10.6' span x 2.7' rise Conc. Box Culverts	xy4112685274118816 / 0.91 out of 1.0 <i>Insignificant Barrier</i>	<10-Year	40' Span Bridge	10-Year	10-Year
Robin Hood Road	8' span x 4.25' rise Conc. Box Culvert	xy4112570874119450 / 0.1 out of 1.0 <i>Severe Barrier</i>	<10-Year	34' Span Bridge	100-Year	50-Year
Brigadoon Drive	8.3' span x 4' rise Conc. Box Culvert	xy4112435274116460 / N/A <i>Yet to be Determined</i>	<10-Year	20' Span Bridge	100-Year	50-Year
Mile Road	16.4' span x 3.8' rise Conc. Box Culvert	xy4112413574114028 / 0.41 out of 1.0 <i>Moderate Barrier</i>	Flanking in <10-Year	34' Span Bridge	50-Year	50-Year

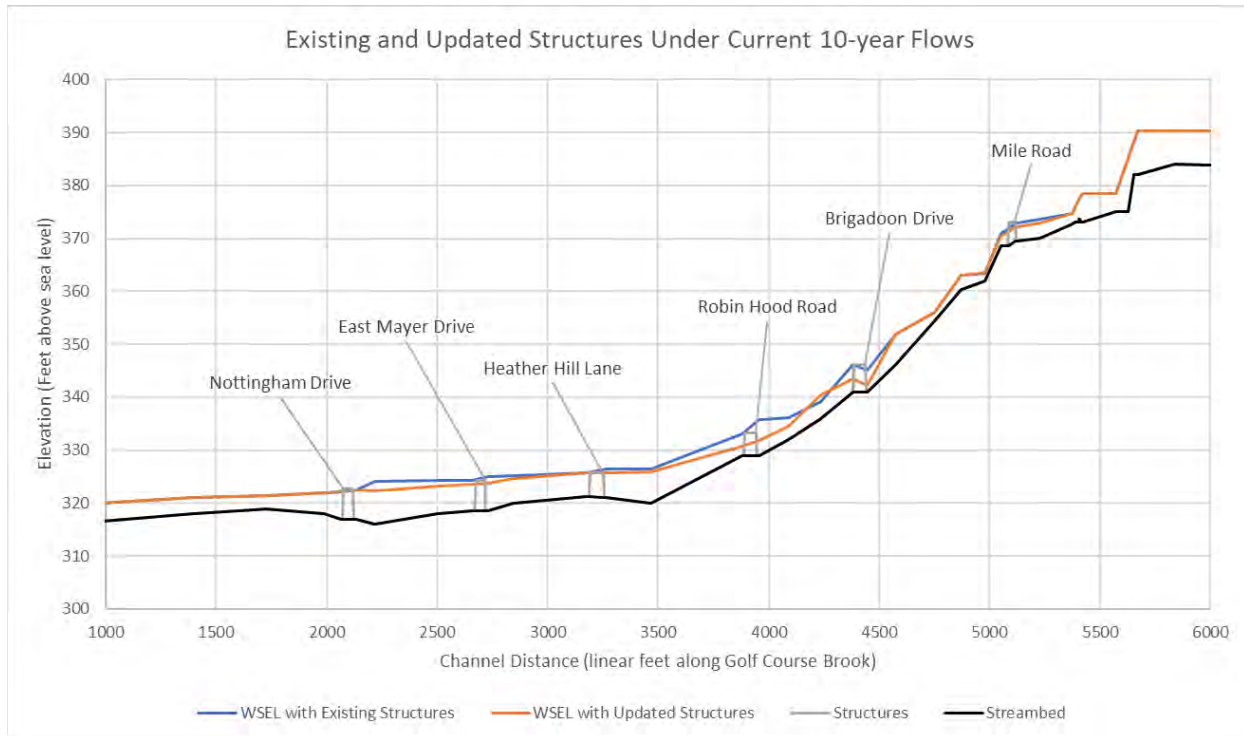


Figure 4-25 Profile of Golf Course Brook

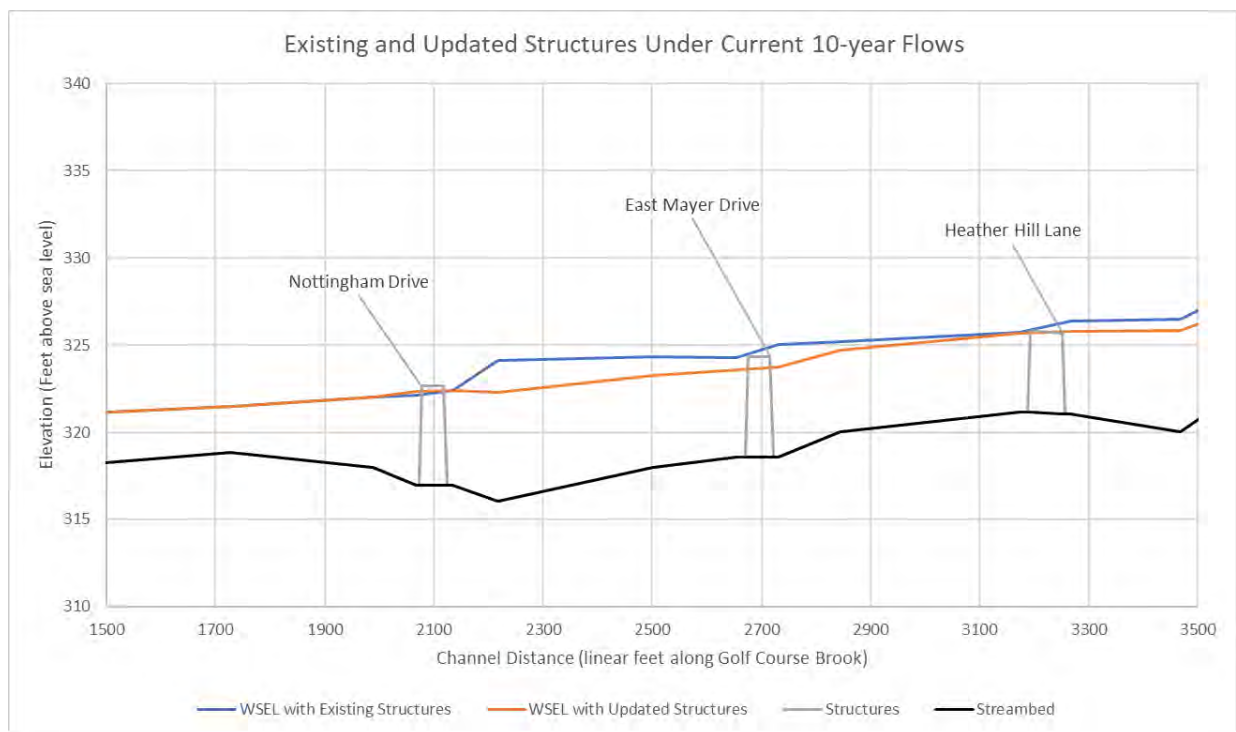
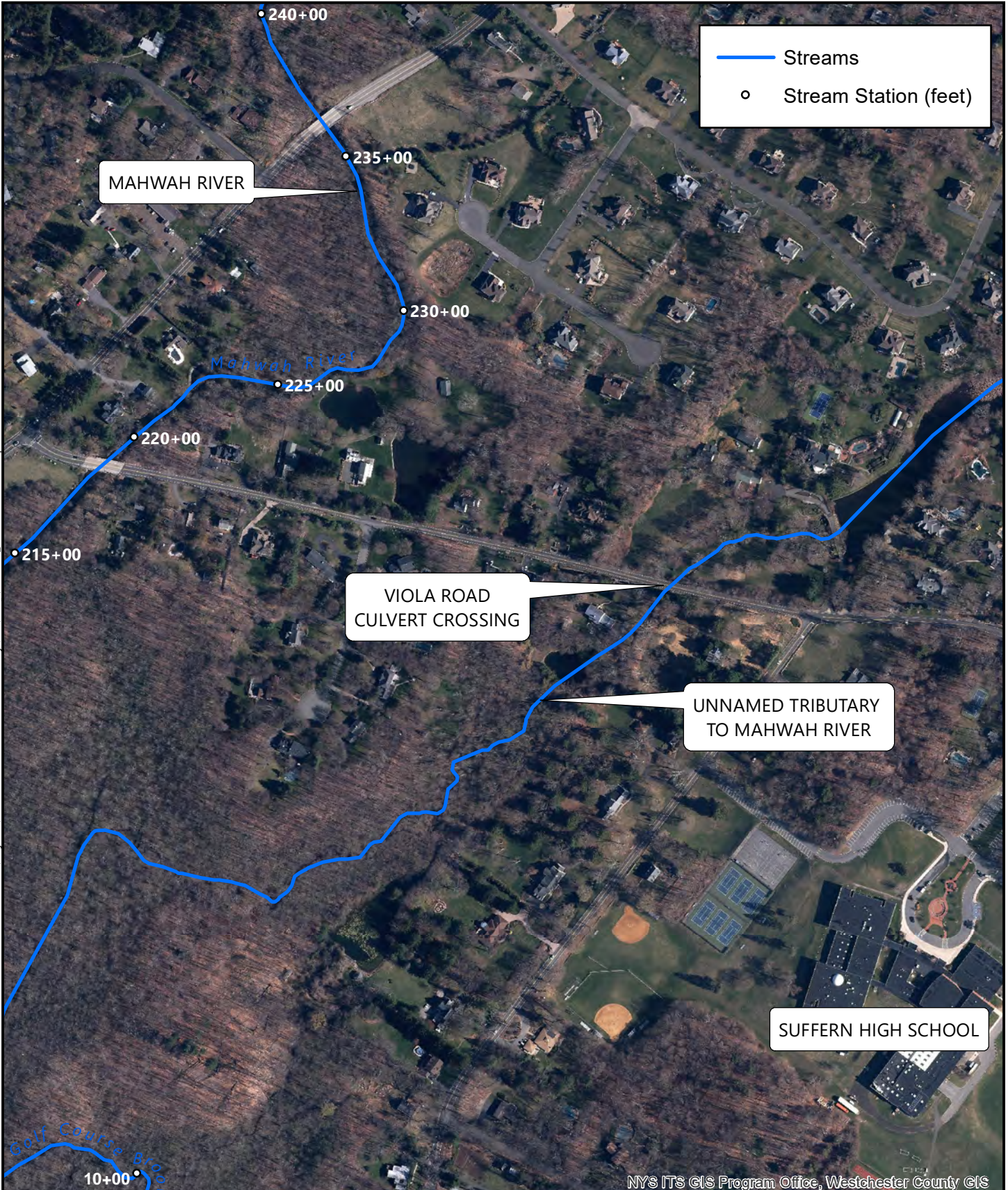


Figure 4-26 Profile of Downstream Reach of Golf Course Brook

At the Viola Road crossing over the unnamed tributary to the Mahwah River (Figure 4-27), no FEMA effective model has been developed. The watershed size of the unnamed tributary at the Viola Road crossing is 1.14 square miles. Viola Road reportedly gets flooded on a regular basis when this crossing is overwhelmed.

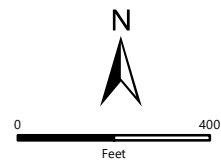
The Viola Road crossing consists of a rectangular opening that has been fitted at its inlet with two round pipes, each 5.7 feet in diameter. The two pipes at the inlet have a lesser hydraulic capacity than the rest of the opening (Figures 4-28 and 4-29). These twin pipes act as a hydraulic constriction, which contributes to flooding and overtopping of the roadway. Based on regional regression equations (Mulvihill, et al., 2010) and field inspection, the unnamed tributary has a bankfull width of approximately 25 feet as it flows through the Viola Road crossing. Therefore, the span of the culvert is recommended to be at least 31 feet wide.



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HIGH RISK AREA #3 - VIOLA ROAD CULVERT

MAHWAH RIVER FLOOD & RESILIENCY STUDY
 SD111
 ROCKLAND COUNTY
 NEW YORK



SCALE 1" = 400'

DATE 9/8/2021

16511.00006
 PROJ. NO.

FIG. 4-27



Figure 4-28 Outlet of Culvert at Viola Road Crossing over Unnamed Tributary to Mahwah River



Figure 4-29 Inlet Pipes on Culvert at Viola Road Crossing Viewed from Outlet

4.4 HIGH RISK AREA #4

HRA 4 includes two road stream crossings on the main stem of the Mahwah River in the town of Ramapo: Sky Meadow Road at STA 320+50 and Mountain Road at STA 475+00. Both stream crossings are reportedly flood prone. Sky Meadow Road has the NAACC crossing code xy4115659074102785 and was evaluated as being an *insignificant barrier* to fish passage with a NAACC aquatic passability score of 0.85

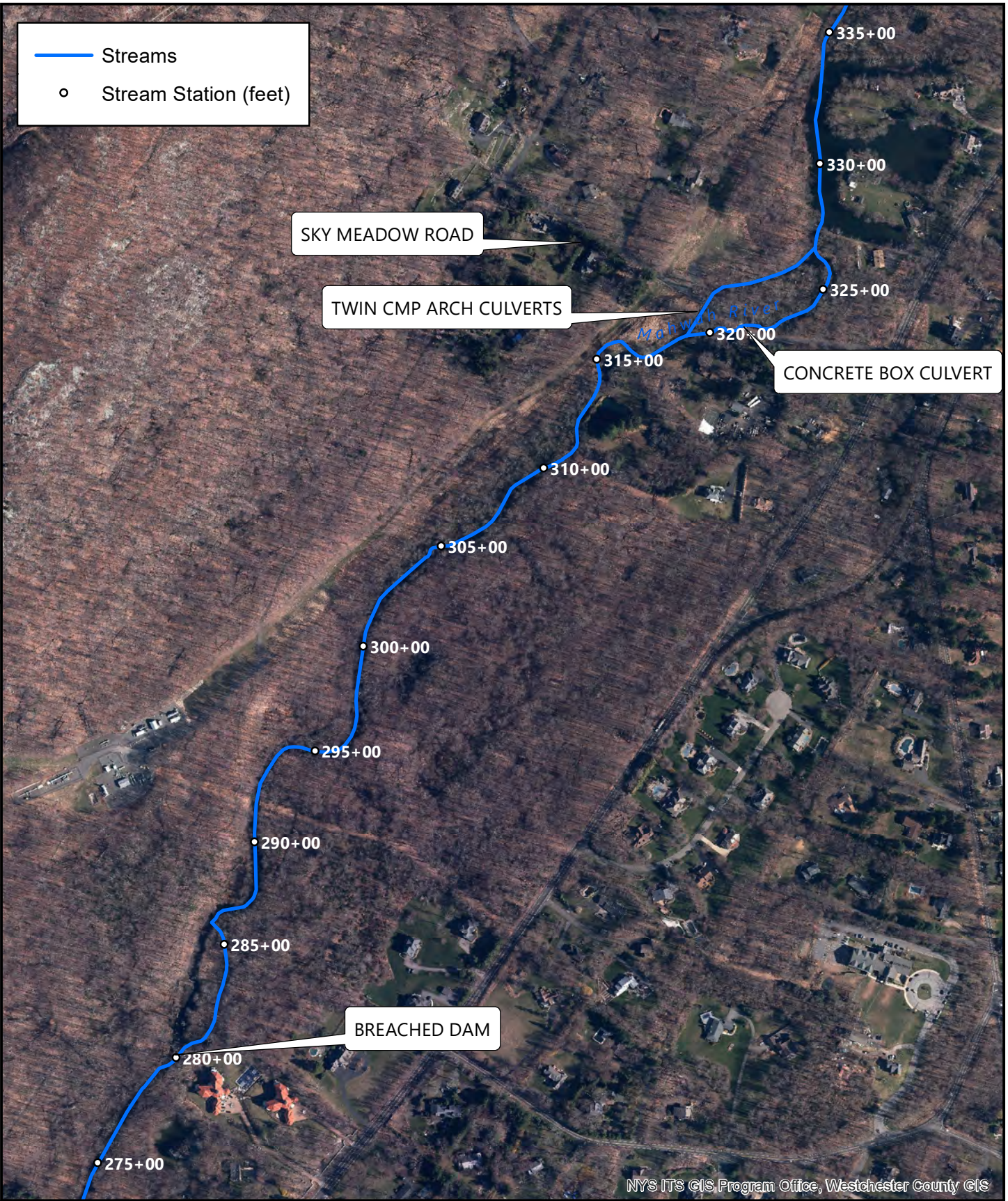
out of 1.0. The NAACC crossing code for Mountain Road is *xy4118657874069627*, and it was classified as *minor barrier* to fish passage with an aquatic passability score of 0.72 out of 1.0. FEMA hydraulic modeling for the Mahwah River is based on an antiquated HEC-2 model dating from the 1980s. The FEMA hydrologic analysis is also outdated. For the purpose of analysis within HRA 4, the USGS gauge (USGS 01387450) located on the Mahwah River downstream of Sky Meadow Road, at the Route 202 crossing, was used to compute peak flow recurrence intervals. A log-Pearson Type III probability distribution was conducted to determine peak flows at the gauge. These flows were then transferred upstream to the Sky Meadow Road and Mountain Road sites. Current and projected future flows for the Mahwah River at the Sky Meadow Road and Mountain Road crossings are reported in Table 4-2 and Table 4-3, respectively.

Table 4-2 Summary of Flows at Sky Meadow Road Crossing

Recurrence Interval (Years)	Current Peak Flows (cfs)	Projected Future Peak Flows (cfs) (RCP 4.5, 2050-2074)	
	Mahwah River at Sky Meadow Road	Mahwah River at Sky Meadow Road	Percent Change (%)
10-Year	1,181	1,311	11
25-Year	1,673	1,858	11
50-Year	2,372	2,372	12
100-Year	2,952	2,952	12

cfs = cubic feet per second

Sky Meadow Road is a dead-end road that serves over a dozen homes (Figures 4-30 and 4-31). The Mahwah River has a drainage area of 10.4 square miles at this location. The river splits into two channels in this area and crosses under Sky Mountain Road at two locations. The first crossing, located closest to Haverstraw Road, consists of a concrete box culvert with a 15.5-foot span, 4.4-foot rise, and a length of 15.5 feet. The second crossing, located farther from Haverstraw Road, consists of two corrugated metal arch pipes, each with a span of 3.6 feet, a rise of 2.35 feet, and a length of 25.1 feet. The roadway reportedly gets overtopped by floodwaters. There is no emergency detour available when the roadway overtops and become impassable to vehicles. The profile for the Mahwah River published in the FEMA FIS for Rockland County shows the Sky Meadow Road crossing overtopping during all modeled flows (10-, 50-, 100-, and 500-year flood events). The profile also indicates that water surface elevations at the Sky Meadow Road crossing are influenced by a backwater condition that may be in part influenced by a dam located approximately 4,000 feet downstream of the crossing at about STA 280+00. Upon site inspection, the dam was observed to be breached (Figure 4-32). However, the remaining remnants of the dam structure may still be influencing upstream water surface elevations and should be considered for removal.



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HIGH RISK AREA #4 - SKY MEADOW ROAD CULVERTS

MAHWAH RIVER FLOOD & RESILIENCY STUDY
 SD111
 ROCKLAND COUNTY
 NEW YORK

SCALE 1" = 500'

DATE 9/8/2021

PROJ. NO. 16511.00006



FIG. 4-30



Figure 4-31 Sky Meadow Road Crossing over Mahwah River



Figure 4-32 Breached Dam Located Approximately 4,000 Feet Downstream of Sky Meadow Road Crossings

An HY-8 analysis was conducted to evaluate the Sky Meadow Road crossings. With the current crossing configuration, Sky Meadow Road was shown to overtop during the 10-year and greater flood event. Widening of the crossings to a combined span of 60 feet did not improve the performance of the crossing or reduce the frequency of roadway overtopping. Increasing the elevation of the Sky Meadow Road roadway combined with increasing the span of the culverts to a combined span of at least 60 feet would be required to prevent overtopping of the roadway.

The Mountain Road crossing (Figures 4-33 and 4-34) is located on the Mahwah River approximately 2.9 miles upstream of the Sky Meadow Road crossing. The Mahwah River has a watershed area of 2.1 square miles at Mountain Road. The culvert at this location was reportedly damaged during Tropical Storm Irene and was recently replaced with a new culvert. The new culvert consists of a corrugated metal arch pipe with a span of 20.4 feet, a rise of 3.6 feet, and a length of 54.2 feet. A second, smaller culvert is located to the right of the arch pipe culvert. It comprises a smooth plastic pipe culvert with a diameter of 3 feet.

Table 4-3 Summary of Flows at Mountain Road Crossing

Recurrence Interval (Years)	Current Peak Flow (cfs)	Future Peak Flow (cfs) (RCP 4.5, 2050-2074)	
	Mahwah River at Mountain Road	Mahwah River at Mountain Road	Percent Change (%)
10-Year	385	427	11
25-Year	561	623	11
50-Year	723	809	12
100-Year	914	1,024	12

cfs = cubic feet per second



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HIGH RISK AREA #4 - MOUNTAIN ROAD CULVERTS

MAHWAH RIVER FLOOD & RESILIENCY STUDY
 SD111
 ROCKLAND COUNTY
 NEW YORK



SCALE 1" = 200'

DATE 9/8/2021

16511.00006
PROJ. NO.

FIG. 4-33



Figure 4-34 Mountain Road Crossing over Mahwah River

An HY-8 analysis was conducted to evaluate the hydraulic capacity of the Mountain Road crossing. With the current crossing configuration, the culvert is unable to pass the modeled 10-year flood event. Based on field measurements and regional regression equations (Mulvihill, et al., 2010), the bankfull width of the Mahwah River at the Mountain Road crossing is approximately 30 feet. Widening the span to 1.25 times the bankfull width increases the span to approximately 38 feet. When modeled with a span of 38 feet, the crossing passed the 10- and 25-year flood events with both the current and future peak flows. To pass the current and future 10-, 25-, and 50-year flood events, the Mountain Road crossing would need to be widened to a 38-foot span, and the slope of the culvert would need to be increased to match the slope of the stream.

5. RECOMMENDATIONS

The Mahwah River watershed is located close to New York City and is part of the densely developed New York Metropolitan Area. Developed land makes up over 40 percent of the land cover in the watershed. The watershed has an extensive network of roads, including many road stream crossings. The watershed includes 641 acres of wetlands, or approximately 4.6 percent of the watershed.

The analysis identified multiple stream crossings along the Mahwah River and its tributaries that are hydraulically undersized. These are described in more detail in section 4 and summarized below. While replacement stream crossing sizes are recommended here, a detailed hydrologic and hydraulic analysis for each crossing is recommended as part of the project design to properly size the replacement structure.

5.1 HRA 1 RECOMMENDATIONS

In HRA 1, the hydraulic constriction of the Franklin Turnpike bridge in New Jersey can exacerbate flooding in the Lonergan Drive neighborhood. When this structure is due for replacement, detailed hydrologic and hydraulic analyses are recommended to inform an adequately sized crossing that will eliminate or reduce backwater flooding. The Norfolk Southern Railroad embankment and bridge constriction have a significant influence on upstream flooding in HRA 1 as well. Further detailed hydrologic and hydraulic analyses are recommended to facilitate provision of supplemental floodplain relief capacity through the embankment and alleviate flooding of the upstream neighborhoods and businesses in New York and New Jersey. Hydraulic modeling and a review of regional regression equations indicate that a minimum bridge span of approximately 75 feet is required at both the Franklin Turnpike bridge and the Norfolk Southern Railroad bridge over the main channel of the Mahwah River. Replacement of either bridge should be accompanied by an updated detailed hydrologic and hydraulic analysis. The most current regulations and guidance from New Jersey environmental and transportation regulatory agencies regarding stream crossing geometry and hydraulic performance should be applied, as well as updated assessments of projected future flows in the watershed.

If voluntary buyouts of flood-prone homes continue in HRA 1 between Lonergan Drive and the Mahwah River, floodplain benching between the road and river along this reach is recommended, as practical. An 80-foot-wide, 1,250-foot-long floodplain enhancement is proposed, requiring between 2 feet and 4 feet of reduction in overbank elevation. This can help alleviate flooding in other parts of the neighborhood that are not immediately adjacent to the river. These benefits would currently be limited to the areas upstream of the direct influence of the backwaters from the downstream crossings discussed above.

5.2 HRA 2 RECOMMENDATIONS

In HRA 2, the Montebello Road bridge was recently rehabilitated; therefore, it would not be practical or cost effective to replace it with a new bridge with a larger span until the bridge is due for replacement due to age or structural instability. It may be feasible to install one or more floodplain relief culverts set adjacent to the bridge. These culverts would serve to add hydraulic capacity to the current bridge opening and would potentially act to reduce the extent and depth of flooding of Lake Road, Marian Drive, and

Montebello Road during major flood events. If compatible with the bridge's structural design, installation of an additional 20-foot span on the right overbank is recommended, along with a 6-foot-diameter culvert on the left overbank. If larger structures are feasible, or if smaller structures are necessary, the largest practical relief provisions are recommended. If the bridge were to be slated for replacement or fitted with relief culverts, a rigorous hydraulic analysis is recommended to determine appropriate hydraulic sizing as a component of the project design. The hydraulic analysis should consider current and projected future flow events, and the most current regulations and guidance from NYSDOT and NYSDEC regarding stream crossing geometry and hydraulic performance should be applied.

5.3 HRA 3 RECOMMENDATIONS

In HRA 3 along Golf Course Brook in the village of Montebello, several crossings were identified as undersized. It is recommended that these crossings be replaced with adequately sized structures. The replacement spans listed in Table 5-1 are recommended as a replacement size. Unless it is not practical to do so, any project to increase the size of these crossings should begin at the downstreammost structure (Nottingham Drive) and proceed upstream.

Table 5-1 Recommended Replacement Structures at Golf Course Brook Crossings

Golf Course Brook Crossing	Recommended Replacement Structure
Nottingham Drive	40' Span Bridge
East Mayer Drive	34' Span Bridge
Heather Hill Lane	40' Span Bridge
Robin Hood Road	34' Span Bridge
Brigadoon Drive	20' Span Bridge or Culvert
Mile Road	34' Span Bridge

At the Viola Road crossing over the unnamed tributary, also located in HRA 3, a replacement structure with a span of at least 31 feet is recommended. At a minimum, the twin pipes at the culvert inlet should be upgraded to match the geometry and hydraulic capacity of the remainder of the structure.

When due for replacement or significant repairs, upgrades to these crossings should be accompanied by updated detailed hydrologic and hydraulic analyses. 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.

5.4 HRA 4 RECOMMENDATIONS

In HRA 4 at the Sky Meadow Road crossing over the Mahwah River, elevation of the roadway in addition to replacement of the culverts with a combined span of at least 60 feet is recommended to prevent overtopping of the roadway at this location. Upgrades to this crossing should be accompanied by updated detailed hydrologic and hydraulic analyses. 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.

It is recommended that removal of the remaining components of the derelict dam located approximately 4,000 feet downstream of Sky Meadow Road be investigated. During site inspection, the dam was observed to be breached. However, during high flow events, the remaining structure may still be influencing water surface elevations upstream of the dam and should be considered for removal.

The existing culverts at the Mountain Road crossing of the Mahwah River appear to be relatively new. When these are due for replacement or major repair, upgrades to this crossing should be accompanied by updated detailed hydrologic and hydraulic analyses. 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 analysis, the crossing should be widened to a span of 38 feet, and the slope of the channel should be increased to match the slope of the stream upstream and downstream. Minor roadway realignment or elevation may be necessary to alleviate flows flanking over the roadway to the right (west) of the crossing during high flow events.

5.5 UPDATED FEMA HYDRAULIC MODELING AND MAPPING

FEMA hydraulic modeling for the main stem of the Mahwah River is based on an antiquated HEC-2 analysis dating from the 1980s. It is recommended that new FEMA modeling for the Mahwah River be developed to reflect current hydraulic and hydrologic conditions. Updates to hydraulic modeling should then be reflected with updated FIRMs. The updated hydraulic modeling and mapping would reflect changes such as bridge replacements, flood mitigation projects, or updated flood hydrology.

5.6 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 Mahwah River 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, in most cases it is recommended that replacements begin at the downstream end and progress sequentially in an upstream direction. Any replacements of or significant upgrades to bridge and culvert crossings should be accompanied by updated detailed hydrologic and hydraulic analyses. 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 as appropriate for the design lifetime of the structure.

5.7 INDIVIDUAL PROPERTY RELOCATIONS OR FLOOD PROTECTION

It is recommended that property owners who have experienced flooding damage in the past seek appropriate flood mitigation strategies whether through voluntary buyouts, relocation, or individual floodproofing measures. As of 2019, NYS DHSES records indicate that 40 properties in the village of Suffern have incurred repetitive or severe repetitive losses due to flooding; 31 of these are located within identified HRAs, with 23 in HRA #1 alone. While substantial flood hazard reductions in HRA #1 can be achieved by the recommendations discussed in Section 5.1, these are long-term solutions that may take years or decades to implement. Pursuit of flood protection measures and relocations in HRA #1 should be targeted as a priority.

A variety of measures are 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.

5.8 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 Mahwah River 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, emergency response, and highway departments are often the best resource for identifying priority areas and repetitively damaged infrastructure.

5.9 COORDINATION WITH DRINKING WATER SOURCE PROTECTION PROGRAM

The Drinking Water Source Protection Program (DWSP2) is a state-run program created to assist municipalities with proactively protecting their drinking water sources. The goal of the program is to help municipalities develop and implement a drinking water source protection plan for the source of their

drinking water, including identification and mapping of drinking water source protection areas. The village of Suffern, located within the lower portion of the Mahwah River watershed, is a DWSP2 participant. It is recommended that efforts to identify and map drinking water source protection areas also include areas such as wetlands and floodplains in the Mahwah River watershed that may have the mutual benefit of providing flood mitigation services.

5.10 COST RANGE OF RECOMMENDED ACTIONS

To assist with prioritization of the above recommendations, Table 5-2 provides a rough estimated cost range for key recommendations. Estimates do not include cost of property buyouts.

Table 5-2: Cost Range of Recommended Actions

	\$500k - \$1M	\$1M - \$5M	> \$5M
HRA 1 – Replacement of Franklin Turnpike bridge			X
HRA 1 – Replacement of Norfolk Southern Railroad bridge			X
HRA 1 – Floodplain bench between Lonergan Drive and the Mahwah River		X	
HRA 2 - Montebello Road bridge replacement			X
HRA 2 - Montebello Road bridge retrofit		X	
HRA 3 – Replacement of Nottingham Drive culvert over Golf Course Brook		X	
HRA 3 – Replacement of East Mayer Drive culvert over Golf Course Brook		X	
HRA 3 – Replacement of Heather Hill Lane culvert over Golf Course Brook		X	
HRA 3 – Replacement of Robin Hood Road culvert over Golf Course Brook		X	
HRA 3 – Replacement of Brigadoon Drive culvert over Golf Course Brook	X		
HRA 3 – Replacement of Mile Road culvert over Golf Course Brook		X	
HRA 3 – Replacement of Viola Road culvert crossing	X		
HRA 4 – Replacement of Sky Meadow Road crossing and road elevation		X	
HRA 4 – Removal of derelict dam located downstream of Sky Meadow Road	X		
HRA 4 – Replacement of Mountain Road culvert crossing	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 New York State, 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 the Mahwah River, 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 Mahwah 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 are 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 Mahwah Watershed. A map with the boundaries of the Mahwah River 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 HAVERSTRAW

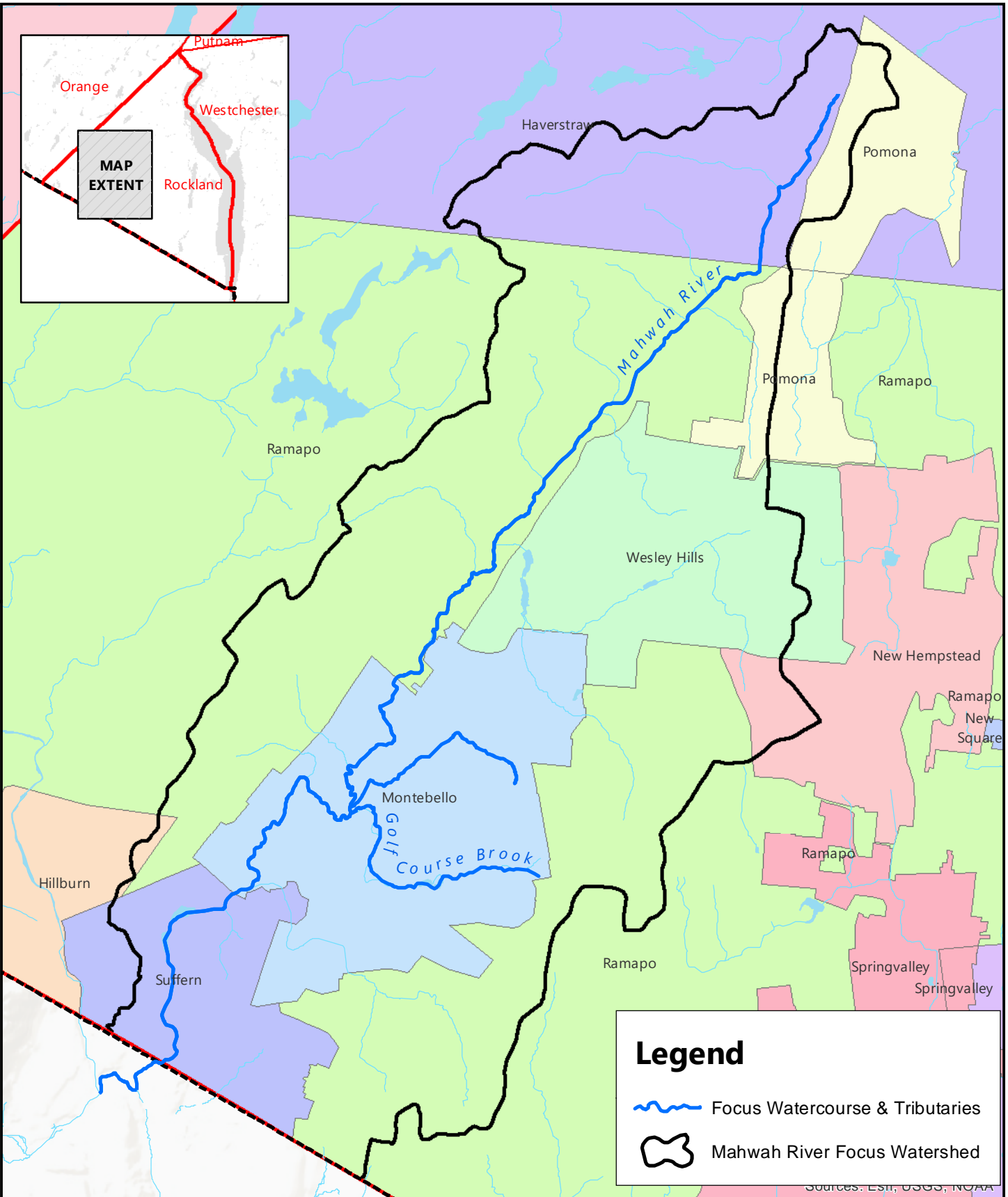
Zoning and Other Code(s) Analysis

<https://ecode360.com/11795031>

The town has a "Flood Damage Prevention" code (Chapter 87). Section 167-65, Floodplain Buffer, has a 15-foot buffer requirement adjacent to the 100-year floodplain. 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 under water or within 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.



Legend

- Focus Watercourse & Tributaries
- Mahwah River Focus Watershed

Sources: Esri, USGS, NOAA

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845.633.8153

MAHWAH RIVER WATERSHED TOWNS & VILLAGES

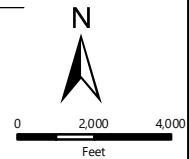
MAHWAH RIVER FLOOD & RESILIENCY STUDY
SD111
ROCKLAND COUNTY
NEW YORK

SCALE 1" = 5,000'

DATE 7/28/2021

PROJ. NO. 16511.00006

FIG. 6-1



- *Rockland Tomorrow: County Comprehensive Plan 2011*
Specific elements detailed in the plan specific to the Town of Haverstraw 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, impede public access to the Hudson River, and exacerbate the challenge of providing ways to safely connect isolated commercial and multifamily housing uses.
 - Floodplains – High flood risk – large flood zones along Hudson River

6.2.2 VILLAGE OF POMONA

Zoning and 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.

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.

6.2.3 VILLAGE OF WESLEY HILLS

Zoning and 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 $\frac{1}{4}$ of the minimum lot area (Section 230-26).

Table of Dimensional Requirements

Not more than 25 percent of any land under water, within a 100-year frequency floodplain, within utility easements or other easements or rights-of-way, or with unexcavated slopes over 25 percent 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.

6.2.4 VILLAGE OF NEW HEMPSTEAD

Zoning and 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.

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 percent 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 100-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 percent shall be counted toward the minimum lot area. Only 75 percent 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 list flooding.
 - There are four areas with 100-year floodplain and one location with a 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 that 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..."

6.2.5 TOWN OF RAMAPO

Zoning and 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. Section 376-42 of the Zoning Ordinance requires that not more than 50 percent of a lot be land under water 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 are related to required yards, but there do not 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 New York State Department of Environmental Conservation as suitable for swimming) rivers or streams, or rivers and streams that 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

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

- 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 MONTEBELLO

Zoning and Other Code(s) Analysis

<https://ecode360.com/8769742>

The village has a Flood Damage Prevention Ordinance (Chapter 92). The code has standards related to elevation and flood-resistant construction. The areas covered by the ordinance include five FIRM panels (as of 2014) and a "Flood Insurance Study, Rockland County, New York, All Jurisdictions." The village also has a Wetland and Stream Protection Ordinance (Chapter 191) that was amended in its entirety in 2018.

Other Land Use documents reviewed:

- 2017 Comprehensive Plan
[Comprehensive Plan | Village of Montebello, New York](#)
 - Develop a Village Greenprint Environmental Protection Overlay District (EPOD). This recommendation is to encourage clustering within environmentally sensitive areas to limit large lot development without increasing average density. Remaining environmentally sensitive areas should be preserved within contiguous open space systems that are protected through easement or dedication to the village and should not be "chopped" up among individual properties wherever possible. It should be clarified that variances are not permitted to be sought in order to increase the density of the standard layout prior to application of average density. *Floodplain, wetland, and steep slopes Environmental Protection Overlay Districts were adopted into the code in 2019.*
 - Revise zoning to limit development within environmentally sensitive areas. The village's current zoning law requires larger minimum lot sizes for properties constrained by certain features, e.g., floodplains, wetlands, water bodies, and steep slopes, in order to protect these sensitive environmental features. The Zoning Code limits but does not prohibit development within these sensitive areas. The plan recommends that the Zoning Code be revised to further limit potential disturbance to the environmentally sensitive features and to provide no credit for sensitive environmental features when determining size. The village could consider increased buffers (up to 300-foot buffers) for certain wetlands and waterways that are in areas specifically prone to flooding, similar to recent New Jersey state regulations. These revisions may be potentially done through the EPOD legislation. *The bulk requirements table has been updated several times since 2017 though these standards apply to all development within the 29 use types, not just those with sensitive environmental areas. The Table of General Use Requirements does not appear to include limitations on development within environmentally sensitive areas by district.*

6.2.7 VILLAGE OF SUFFERN

Zoning and Other Code(s) Analysis

<https://ecode360.com/13756491>

The Village of Suffern has a Flood Damage Prevention Ordinance (Chapter 141). The code has standards related to elevation and flood-resistant construction. The village also has a Floodplain District regulation in Chapter 266 (Zoning) Section 266-17 that restricts the construction or placement of structures which will "...adversely affect the efficiency or the capacity of the floodway or increase flood heights, cause increased velocities or obstruct or otherwise catch or collect debris which will obstruct flow under flood conditions."

Other Land Use documents reviewed:

- Village Comprehensive Plan – An update to the Comprehensive Plan for the village is currently out to bid. The Request for Proposals states that there are no known copies of the existing plan.

6.3 ZONING-RELATED RESILIENCY RECOMMENDATIONS

6.3.1 ELEVATION DESIGN AND SCREENING BEST PRACTICES

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 Mahwah River 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 Haverstraw

Table 6-2: Village of Pomona

Table 6-3: Village of Wesley Hills

Table 6-4: Village of New Hempstead

Table 6-5: Town of Ramapo

Table 6-6: Village of Montebello

Table 6-7: Village of Suffern

Based on the preliminary analysis undertaken through the audit, 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.

6.3.2 BULK AND AREA REQUIREMENT FLEXIBILITY

All communities should consider assessing and revising bulk and area requirements to provide flexibility to permit 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 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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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).	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 6-1 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.	✓	<input type="checkbox"/>	<input type="checkbox"/>	
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.	✓	<input type="checkbox"/>	<input type="checkbox"/>	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.	✓	<input type="checkbox"/>	<input type="checkbox"/>	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Ensure that well heads are above the BFE.	✓	<input type="checkbox"/>	<input type="checkbox"/>	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.	✓	<input type="checkbox"/>	<input type="checkbox"/>	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.	✓	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 6-1 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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The code states that the Planning Board can modify provisions to enable and encourage flexibility of design and development of land in such a manner as to promote the most appropriate use of land. 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.
Prohibit subdivisions in floodprone areas.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Stream stabilization - A few dozen feet to a few hundred feet.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Flood attenuation – A few dozen to several hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>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.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Protection of cold water fisheries – A few dozen feet to a few hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require restoration of impaired riparian zones as a condition of subdivision approval.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Restrict potentially problematic uses (Hazardous materials uses, for example)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Dedicate land for public facilities and services.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Any property with a floodplain should be required to show such information on the plan.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require conservation easements around flood-prone areas or floodplains.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 6-1 Flood Resiliency Best Practices Code Audit Checklist

Town of Haverstraw, NY Preliminary Audit	<i>In Existing Code</i>	<i>Consider for Implementation</i>	<i>N/A</i>	<i>Notes</i>
Require green infrastructure or low-impact development techniques, where feasible	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

See Chapter 3 of this report for source information.

Code Sections Reviewed:

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 6-2 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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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).	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 6-2 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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Ensure that well heads are above the BFE.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit new development unless effect on flooding is minimal or zero.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 6-2 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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit subdivisions in floodprone areas.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Stream stabilization - A few dozen feet to a few hundred feet.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Flood attenuation – A few dozen to several hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>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.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Protection of cold water fisheries – A few dozen feet to a few hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require restoration of impaired riparian zones as a condition of subdivision approval.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Restrict potentially problematic uses (Hazardous materials uses, for example)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Dedicate land for public facilities and services.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Any property with a floodplain should be required to show such information on the plan.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require conservation easements around flood-prone areas or floodplains.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 6-2 Flood Resiliency Best Practices Code Audit Checklist

Village of Pomona, NY Preliminary Audit	<i>In Existing Code</i>	<i>Consider for Implementation</i>	<i>N/A</i>	<i>Notes</i>
Require green infrastructure or low-impact development techniques, where feasible	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

See Chapter 3 of this report for source information.

Code Sections Reviewed:

Flood Damage Prevention - Chapter 79

Subdivision of Land - Chapter 118

Stormwater Management - Chapter 114

Wetlands - Chapter 126

Table 6-3 Flood Resiliency Best Practices Code Audit Checklist				Notes
Village of Wesley Hills Preliminary Audit	In Existing Code	Consider for Implementation	N/A	
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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).	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 6-3 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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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. The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system. 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. 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.
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Ensure that well heads are above the BFE.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit new development unless effect on flooding is minimal or zero.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.
Prohibit subdivisions in floodprone areas.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 6-3 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:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Stream stabilization - A few dozen feet to a few hundred feet.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Flood attenuation – A few dozen to several hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>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.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Protection of cold water fisheries – A few dozen feet to a few hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require restoration of impaired riparian zones as a condition of subdivision approval.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Restrict potentially problematic uses (Hazardous materials uses, for example)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Dedicate land for public facilities and services.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Any property with a floodplain should be required to show such information on the plan.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require conservation easements around flood-prone areas or floodplains.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require green infrastructure or low-impact development techniques, where feasible	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

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 6-4 Flood Resiliency Best Practices Code Audit Checklist				Notes
Village of New Hempstead Preliminary Audit	In Existing Code	Consider for Implementation	N/A	
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces. 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 relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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).	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 6-4 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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Ensure that well heads are above the BFE.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit new development unless effect on flooding is minimal or zero.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit subdivisions in floodprone areas.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 6-4 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:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Stream stabilization - A few dozen feet to a few hundred feet.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Flood attenuation – A few dozen to several hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>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.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Protection of cold water fisheries – A few dozen feet to a few hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require restoration of impaired riparian zones as a condition of subdivision approval.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Restrict potentially problematic uses (Hazardous materials uses, for example)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Dedicate land for public facilities and services.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require conservation easements around flood-prone areas or floodplains.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require green infrastructure or low-impact development techniques, where feasible	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

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

Table 6-5 Flood Resiliency Best Practices Code Audit Checklist				Notes
Town of Ramapo Preliminary Audit	In Existing Code	Consider for Implementation	N/A	
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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).	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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. The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system. 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. 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.
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Ensure that well heads are above the BFE.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit new development unless effect on flooding is minimal or zero.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	There is a cluster provision in the code.
Prohibit subdivisions in floodprone areas.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Stream stabilization - A few dozen feet to a few hundred feet.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Flood attenuation – A few dozen to several hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>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.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Protection of cold water fisheries – A few dozen feet to a few hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require restoration of impaired riparian zones as a condition of subdivision approval.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Restrict potentially problematic uses (Hazardous materials uses, for example)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Dedicate land for public facilities and services.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Any property with a floodplain should be required to show such information on the plan.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require conservation easements around flood-prone areas or floodplains.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require green infrastructure or low-impact development techniques, where feasible	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

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 Montebello 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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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).	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 6-6: Flood Resiliency Best Practices Code Audit Checklist

Village of Montebello 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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	This exists in a way in the code. Within special flood hazard areas, construction or improvements are prohibited without a valid floodplain development permit. Construction, alteration or enlargement of any habitable building in a 100-year flood area requires Planning Board site development plan review in addition to a floodplain 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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Ensure that well heads are above the BFE.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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 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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The code prohibits construction, alteration or enlargement of any habitable building in a 100-year flood area without a floodplain permit and Planning Board site plan approval.
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit subdivisions in floodprone areas.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Code requires proposals to minimize flood-related 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 6-6: Flood Resiliency Best Practices Code Audit Checklist				
Village of Montebello 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:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Stream stabilization - A few dozen feet to a few hundred feet.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Flood attenuation – A few dozen to several hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>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.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Protection of cold water fisheries – A few dozen feet to a few hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require restoration of impaired riparian zones as a condition of subdivision approval.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Restrict potentially problematic uses (Hazardous materials uses, for example)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Dedicate land for public facilities and services.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Floodplain information is required per §92-13.
Any property with a floodplain should be required to show such information on the plan.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require conservation easements around flood-prone areas or floodplains.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require green infrastructure or low-impact development techniques, where feasible	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

See Chapter 3 of this report for source information.

Code Sections Reviewed:

Flood Damage Prevention - Chapter 92

Subdivision of Land - Chapter 163

Stormwater Pollution Prevention Plan - §158-28

Wetland and Stream Protection Ordinance - Chapter 191

Table 6-7: Flood Resiliency Best Practices Code Audit Checklist

<p>Village of Suffern, NY Preliminary Audit</p>	<p>In Existing Code</p>	<p>Consider for Implementation</p>	<p>N/A</p>	<p>Notes</p>
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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).	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Table 6-7: Flood Resiliency Best Practices Code Audit Checklist				
Village of Suffern, 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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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. The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system. 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. Code prohibits development encroachment if it 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. Authorization is required for work in flood prone areas.
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Ensure that well heads are above the BFE.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit new development unless effect on flooding is minimal or zero.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Cluster development must be considered for projects in the Critical Environmental Area Overlay District and Board of Trustees approval for such development must be given.
Prohibit subdivisions in floodprone areas.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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. 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 Suffern, 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:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Stream stabilization - A few dozen feet to a few hundred feet.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Flood attenuation – A few dozen to several hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>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.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<i>Protection of cold water fisheries – A few dozen feet to a few hundred feet</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require restoration of impaired riparian zones as a condition of subdivision approval.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Restrict potentially problematic uses (Hazardous materials uses, for example)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Dedicate land for public facilities and services.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Any property with a floodplain should be required to show such information on the plan.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require conservation easements around flood-prone areas or floodplains.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Require green infrastructure or low-impact development techniques, where feasible	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	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.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

See Chapter 3 of this report for source information.

Code Sections Reviewed:

Flood Damage Prevention - Chapter 141

Floodplain District - §266.17

Critical Environmental Area Overlay District - § 266.18

Subdivision of Land - Chapter 239. *Note: This code section included a note stating that the regulations are under review and will be included in the code when the process is complete. As such, there were no standards to review for this assessment*

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