FLOOD MITIGATION & RESILIENCE REPORT

Little Chazy River - SD122

Prepared for:

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

SLR #142.16511.00012.0040
June 2022

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New York State Office of General Services
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Cover photo: Flooding at the confluence of the Little Chazy River with Lake Champlain in 2011. Image provided by Clinton County Department of Emergency Services.

CONTENTS

FIGURES

TABLES

ACRONYMS

ASR	Alkali-silica reaction
BFE	Base Flood Elevation
CFS	Cubic Feet per Second
CRRA	Community Risk and Resiliency Act
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FPMS	Floodplain Management Services Program
FPS	Feet per second
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center – River Analysis System
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HRA	High Risk Area
HWMS	High water marks
MPH	Miles per hour
NAVD88	North American Vertical Datum of 1988
NBI	National Bridge Inventory
NFIP	National Flood Insurance Program
NGVD29	National Geodetic Vertical Datum of 1929
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
NYSEG	New York State Electric and Gas
NYSOGS	New York State Office of General Services
RFC	Repetitive Flood Claims
SFHA	Special Flood Hazard Area
SRL	Severe Repetitive Loss
STA	Station
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

SUMMARY

This work is a component of the Resilient New York Program, an initiative of the New York State Department of Environmental Conservation. The goal of the Resilient New York Program is to make New York State more resilient to flooding and climate change. The Little Chazy River originates in the Flat Rock State Forest, north of Robinson, New York. The river flows southeast to West Chazy, turns generally northeastward toward Chazy, and continues east-northeast to Lake Champlain.

Clinton County has an active history of floods, flash floods, and ice jamming. According to National Oceanic and Atmospheric Administration (NOAA) records, Clinton County has experienced 16 flash floods or flooding events, including lakeshore flooding, since 2000. Thirteen of those events occurred from 2007 to 2012. Ice jams typically occur in the springtime and are caused by melting snow and ice that creates blockages in a river, effectively producing flooding. Clinton County has experienced 15 ice jam events from 2004 to 2011.

As part of this analysis, two flood-prone High Risk Areas (HRAs) within the Little Chazy 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. Flood and ice jam mitigation scenarios such as floodplain enhancement, dam removal, and replacement of undersized bridges and culverts are investigated and are recommended where appropriate.

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 Little Chazy River originates in the Flat Rock State Forest, north of Robinson, New York. The river flows southeast to West Chazy, turns generally northeastward toward Chazy, and continues east-northeast to Lake Champlain, where it empties across from the northern end of Isle La Motte.

This report begins with an overview of the Little Chazy River watercourse and watershed, summarizes the history of flooding, and identifies HRAs within the watershed. An analysis of flood mitigation considerations within each HRA is undertaken. Flood mitigation recommendations are provided either as HRA-specific recommendations or as overarching recommendations that apply to the entire watershed or stream corridor. Flood mitigation scenarios such as floodplain enhancement and channel restoration, road closures, and replacement of undersized bridges and culverts are investigated and are recommended where appropriate.

According to Jamieson and Morris, the word “Chazy” is an adaptation of a French lieutenant named *Chezy,* who was killed by Iroquois Indians in 1666 near the Great Chazy River mouth. During the early 1900s, philanthropist and entrepreneur William Henry Miner acquired 13,150 acres of land in Chazy. That is where he built Heart’s Delight Farm and various other institutions, including a two-million-dollar school and a wild animal preserve. His enterprise extended upstream as far as Chazy Lake, where he also constructed a still-existing dam in 1926. The Miner Foundation has given at least 700 acres of land to New York State since 1963 and remains an integral part of the region’s history.

1.2 TERMINOLOGY

In this report, all references to right bank and left bank refer to "river right" and "river left," meaning the orientation assumes that the reader is standing in the river, looking downstream. Stream stationing is used in the narrative and on maps as an address to identify specific points along the watercourse. Stationing is measured in feet and begins at station (STA) 0+00 at the Little Chazy River’s confluence with Lake Champlain and continues upstream to the headwaters in the Flat Rock State Forest at STA 1125+00. As an example, the US-9 crossing of the Little Chazy River in the Hamlet of Chazy is located at STA 250+80.

The Little Chazy River watershed measured at its outlet to Lake Champlain 2 miles south of the Great Chazy River is 54.1 square miles in size and has a main stem length of 22 miles.

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 Little Chazy River and its tributaries.

2. DATA COLLECTION

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

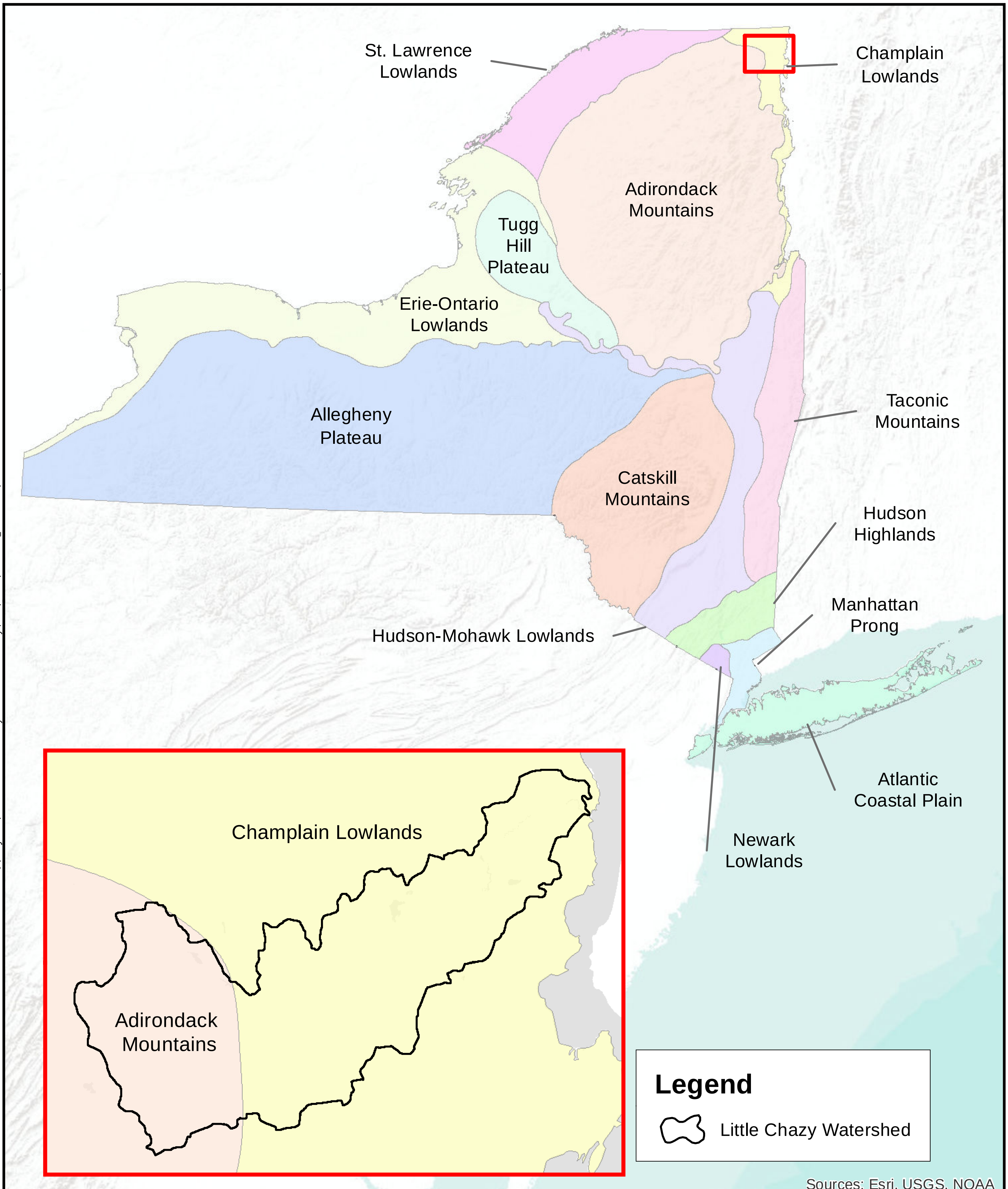
2.1 THE LITTLE CHAZY RIVER WATERSHED CHARACTERISTICS

The Little Chazy River watershed is located in Clinton County, in northeastern New York State, and falls within the physiographic regions known as the Adirondack and Champlain Lowlands (Figure 2-1). The watershed flows in a generally southwesterly direction to West Chazy, turns generally northeastward toward Chazy, and continues east-northeast to Lake Champlain, draining the eastern portions of Clinton County. Nearly the entire town of West Chazy, the town of Chazy, the southern portion of Altona, and the town of Robinson drain to the Little Chazy River.

The Little Chazy River watershed is oblong in shape, narrowing toward its outlet to Lake Champlain in New York. When measured at its outlet, the watershed is 54.1 square miles in size. Elevations in the western portion of the watershed in the Adirondack Mountains approach 1,500 feet while the outlet to Lake Champlain is less than 100 feet elevation. Figure 2-2 is a watershed map of the Little Chazy River watershed. Figure 2-3 is a relief map of the watershed.

Bedrock underlying the northwestern Little Chazy River watershed largely consists of Potsdam Sandstone. Potsdam Sandstone comprises of a well-cemented quartz sandstone that formed during the Cambrian Period. The lower central section of the Little Chazy watershed consists of the Beekmantown Group. The Beekmantown Group dates from the Lower Ordovician Period and is defined by dolostone and limestone. In addition, the Little Chazy River watershed is underlain by several groups of bedrock dating from the Middle Ordovician Period. To the east, a small section of bedrock is mapped as the Chazy Group. The Chazy Group is made up of the Day Point, Crown Point, and Valcour limestone. They primarily comprise of limestone and contain some layers of sandstone and shale found in the Day Point and Valcour limestone, respectively. In the northern area of the watershed, the bedrock is mapped as the Trenton Group and consists of limestone with intermittent shale layers.

The Champlain Lowlands went through periods of glaciation during the Pleistocene Epoch. A glacial lake termed Glacial Lake Vermont extended across upper New York, parts of Vermont, and parts of Canada. Clay and silt were deposited in the bottom of the lake along with sand. The glaciers melted and retreated after some time. Sea level then rose, and a shallow sea deposited sand in the area. Surficial materials underlying the Little Chazy River watershed consist primarily of glacial till, with small areas intermittently dispersed throughout the watershed mapped as exposed bedrock or areas of bedrock that are around 3 to 10 feet from the surface. Sections mapped as kame deposits are contained in the southern portion of the watershed. Kame deposits are glacial legacy sediments composed of sand, gravel, and till. In the eastern section of the Little Chazy River watershed, areas mapped as marine beach sediment, defined as well-sorted sand and gravel, and lacustrine silt and clay are found.



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NYS PHYSIOGRAPHIC REGIONS
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SCALE 1 " = 18,597 '
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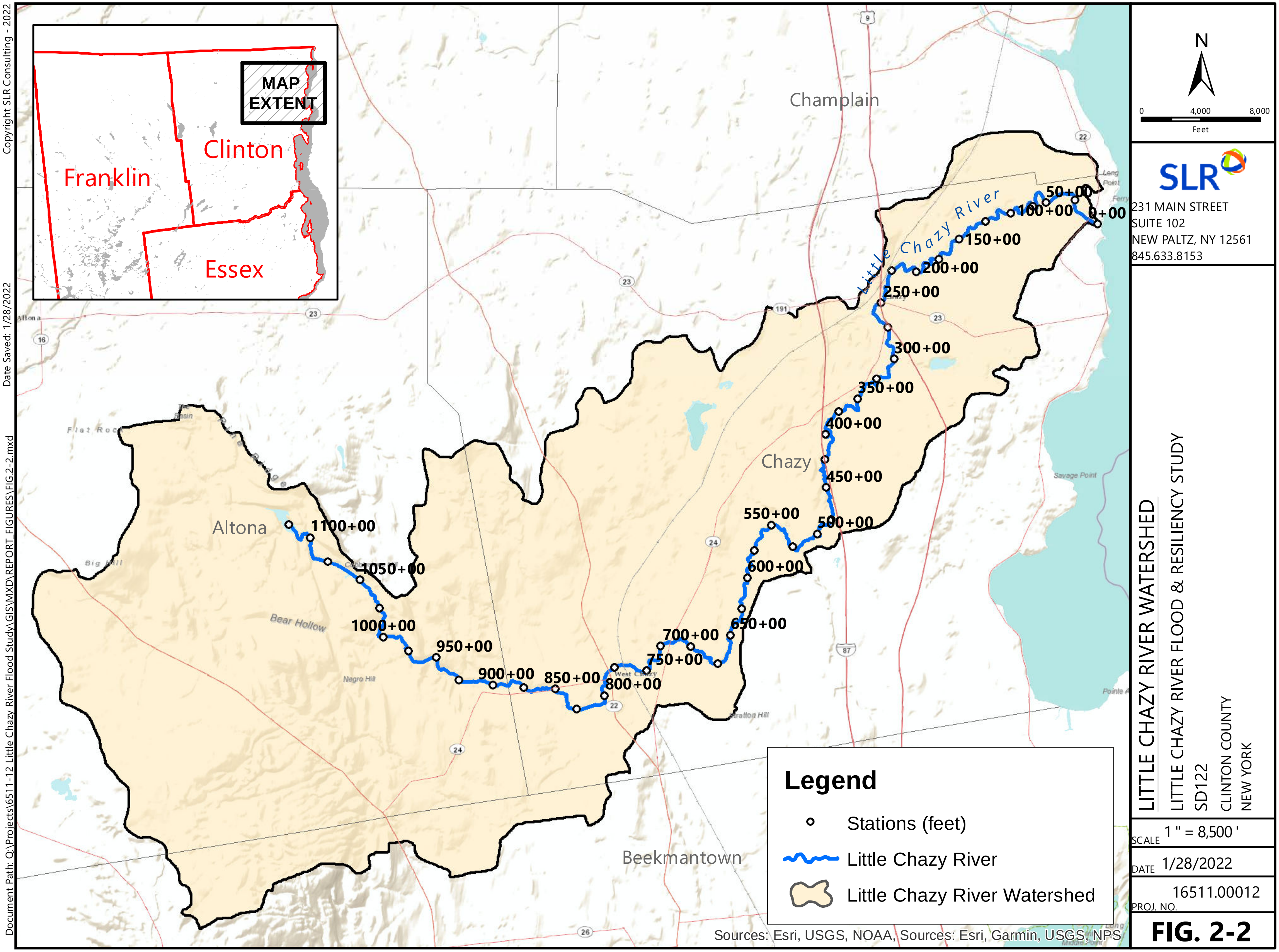
FIG. 2-1



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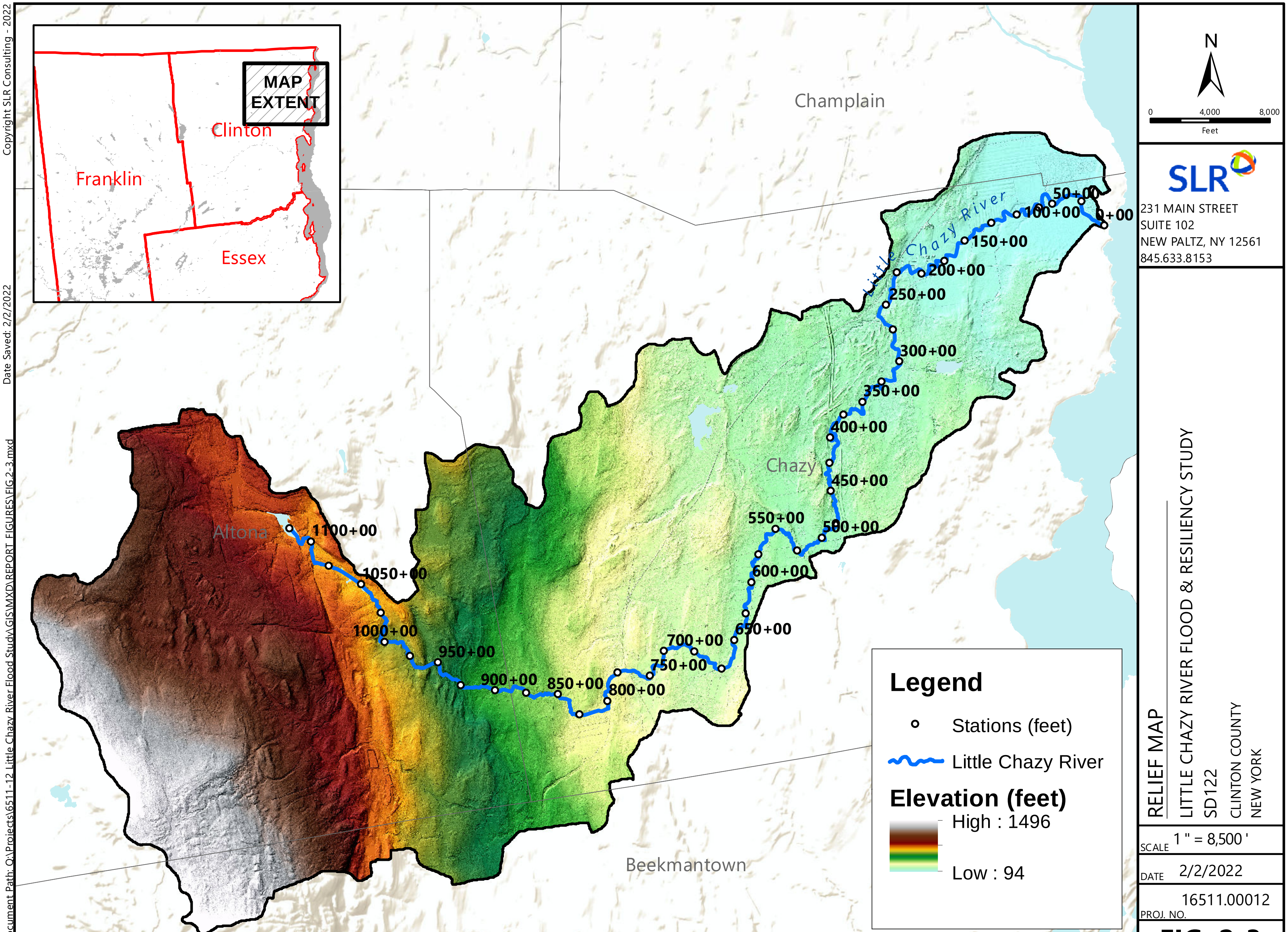
MAP EXTENT
Clinton
Franklin
Essex
Champlain
Chazy
Altona
Beekmantown
Little Chazy River
0+00
50+00
100+00
150+00
200+00
250+00
300+00
350+00
400+00
450+00
500+00
550+00
600+00
650+00
700+00
750+00
800+00
850+00
900+00
950+00
1000+00
1050+00
1100+00
Legend
Stations (feet)
Little Chazy River
Elevation (feet)
High : 1496
Low : 94
Sources: Esri, USGS, NOAA
N
0
4,000
8,000
Feet
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RELIEF MAP
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NEW YORK
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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 runoff 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. Approximately 39 percent of the mapped soils in the Little Chazy River watershed are classified as hydrologic soil group C, C/D, or D, indicating a low capacity for infiltration and a high tendency for runoff (Figure 2-4). This contributes to flash flooding in the watershed as rainfall runoff moves swiftly into streams rather than gradually seeping through the soils. A large portion of the mapped soils in the Little Chazy River are classified as hydrologic soil group B/D (31%), which can indicate a high tendency for runoff in large magnitude rainfall events.

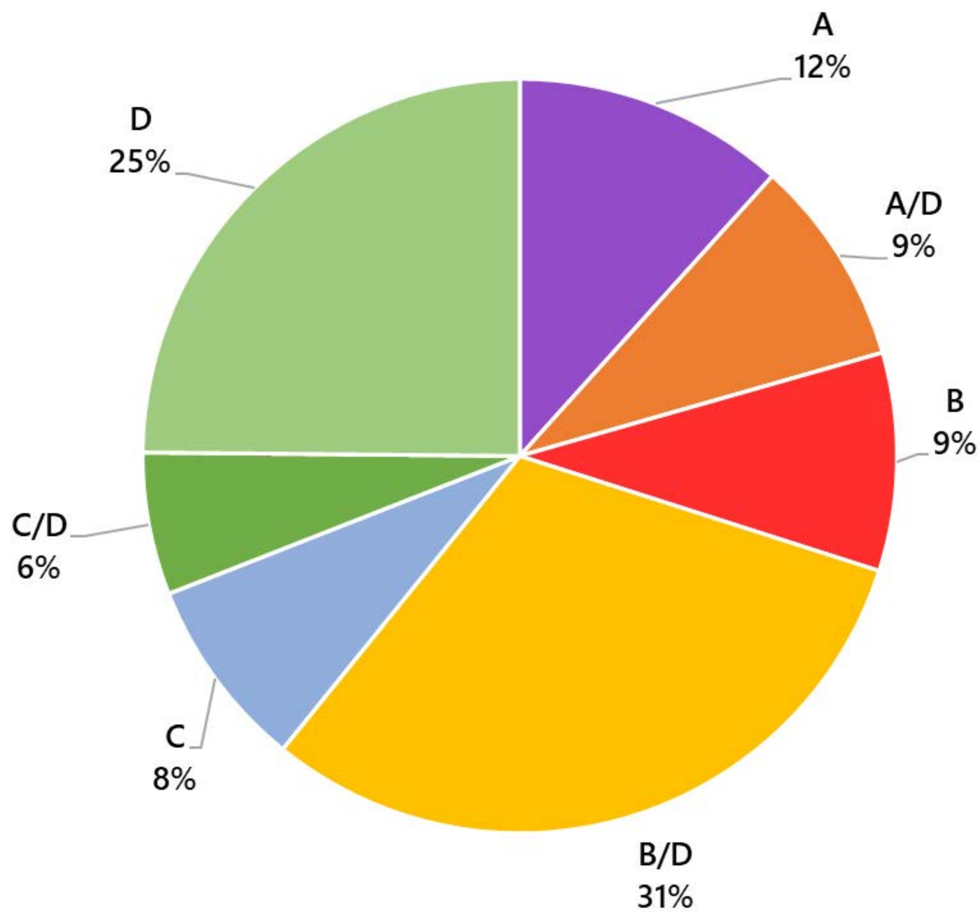


Figure 2-4: Hydrologic Grouping of Soils within the Little Chazy River Watershed

Land cover is another important factor influencing the runoff characteristics of a watershed. Land cover within the Little Chazy River watershed can be characterized using the 2016 Multi-Resolution Land Characteristics National Land Cover Database for Northeast New York State and is shown graphically in Figure 2-5. Forested land is the most common land cover, representing 53 percent of the watershed.

Forested land consists of deciduous, coniferous, and mixed forest types. Agricultural land makes up 23 percent of the watershed. Open water and wetlands combined make up 14 percent of the land cover. Development land makes up 5 percent of the watershed. The remaining 6 percent of the land cover consists of grassland and shrubland, and barren land.

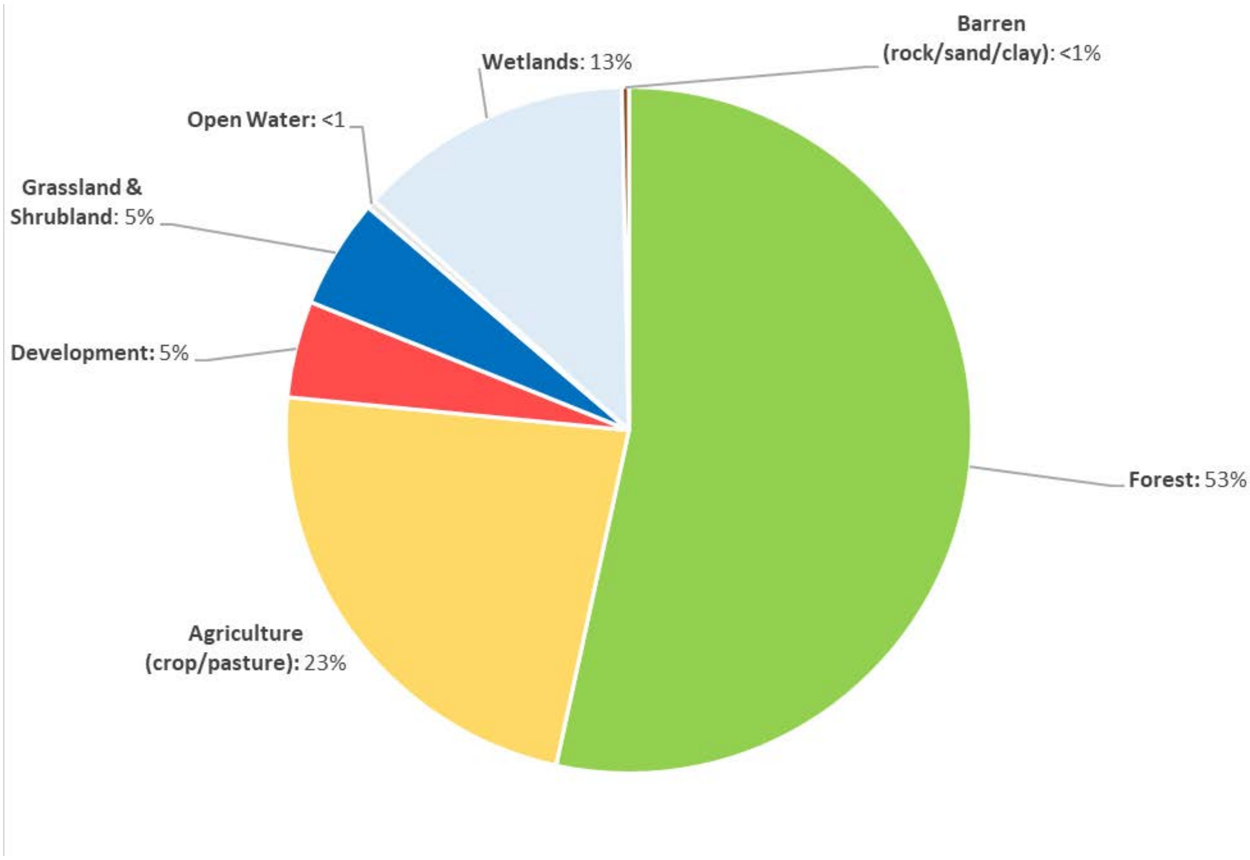


Figure 2-5: Land Cover within the Little Chazy River Watershed

> 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.

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 approximately 4,089 acres of wetlands in the Little Chazy River watershed, or approximately 13 percent of the watershed. This amount is consistent with the estimates above based on land cover and includes the following types of wetland habitats: freshwater forest/shrub wetland, freshwater emergent wetland, freshwater pond, lake (reservoirs), and riverine wetland. Many of the larger wetlands within the watershed are New York State-regulated freshwater wetlands. 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.

2.2 THE LITTLE CHAZY RIVER WATERCOURSE

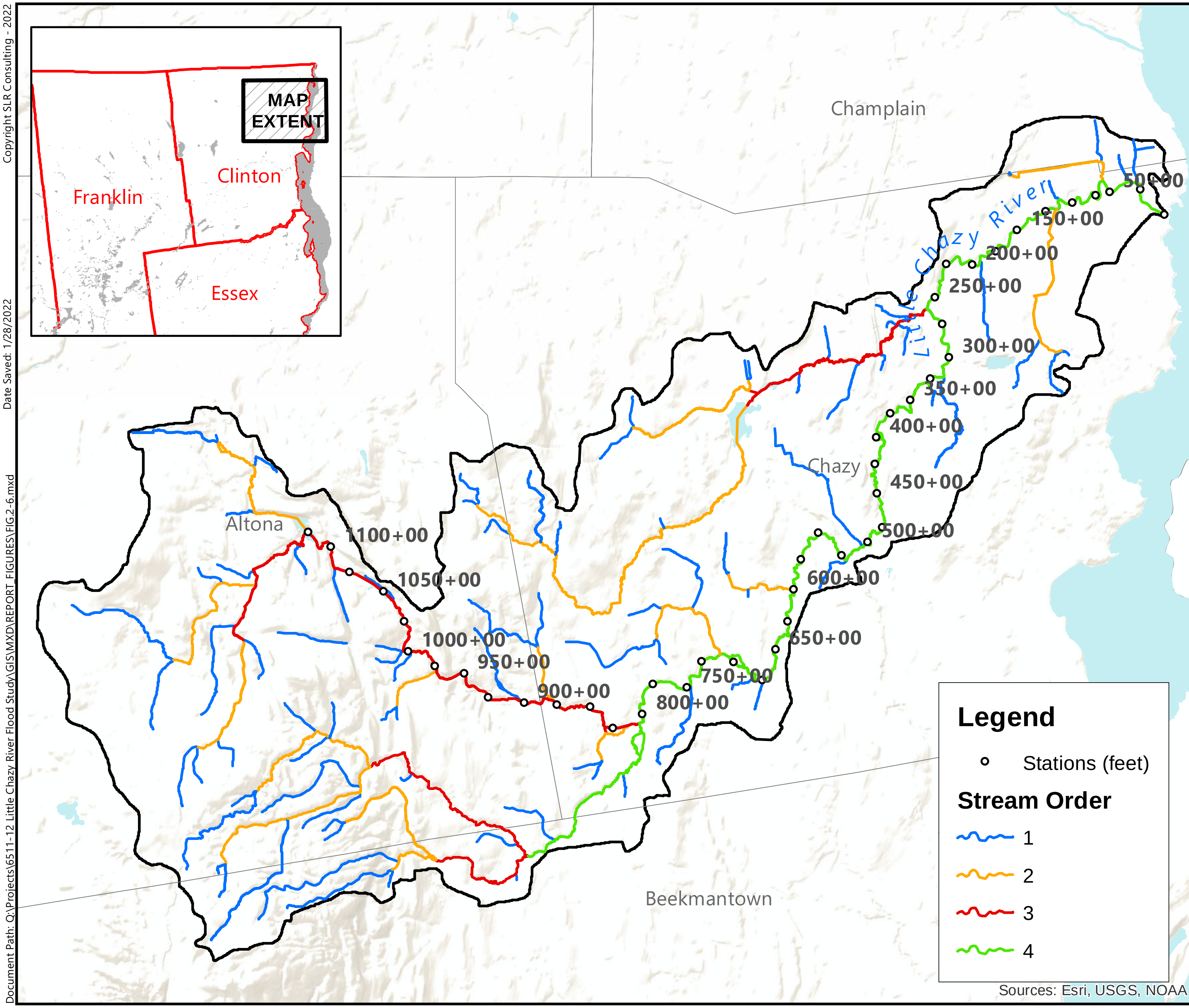
The Little Chazy River originates in Flat Rock State Forest and flows southeast to West Chazy, turns generally northeastward toward Chazy, and continues east-northeast to Lake Champlain, where it empties across from the northern end of Isle La Motte. Named tributaries to the main stem include Farrell Brook, Tracy Brook, Cold Brook, Robinson Brook, and Boyington Brook.

Stream order provides a measure of the relative size of streams by assigning a numeric order to each stream in a stream network. The smallest tributaries are designated as first-order streams, and the designation increases as tributaries join. The main stem of the Little Chazy River can be characterized as a fourth-order stream for most of its length. Larger tributaries such as Farrell Brook and Tracy Brook are third-order streams. An example of a second-order stream includes Boyington Brook. Many of the first-order streams are unnamed. Figure 2-6 is a map depicting stream order in the Little Chazy River watershed.

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 Little Chazy River watershed (72%). First-order streams are steeper in slope than second- and third-order streams, which are steeper than the fourth-order main stem of the Little Chazy River.

Table 2-1 Stream Order Characteristics in the Little Chazy River Watershed

Stream Order	Total Length (miles)	Percentage of Overall Network Length (%)	Average Slope (%)
1st	54.9	46%	2.14
2nd	31.1	26%	1.51
3rd	15.1	13%	1.49
4th	19.0	16%	0.89
Total	**120.14**	**100%**	



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STREAM ORDER
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FIG. 2-6

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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 (4 percent) chance of occurring 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.

A simplified diagram of the hydrologic cycle is presented in Figure 2-7.

The USGS has operated a flow gauge on the Little Chazy River, about 2 miles downstream of the hamlet of Chazy, since 1990 (04271815). A USGS bulletin 17B analysis of this station’s record was compared to regional regressions detailed in USGS SIR 2006-5112, which were employed to determine peak flows reported in the 2020 Preliminary Flood Insurance Study (FIS) for Clinton County (36019CV001B), and gauge record-regression weighted flood hydrology computed for USGS SIR 2014-5084.

Results of these hydrologic methods are relatively consistent and are compared for the site of the USGS gauge in Table 2-2. Scaling each of these methods to other locations in the watershed would utilize the same area-weighting equations. The regional regressions/FEMA flows tend to be more conservative in most scenarios assessed. For this reason, and for consistency with regulatory flood hazard mapping, these were used for the subject study. Peak flows at key locations in the watershed are presented in Table 2-3.

Table 2-2 Comparison of Peak Flood Magnitudes at the USGS Gauge Location on the Little Chazy River

METHOD	ESTIMATED PEAK FLOOD DISCHARGE AT USGS GAUGE 04271815 (CFS)				
	10-Year	25-Year	50-Year	100-Year	500-Year
USGS 17B	1,480	2,000	2,460	2,980	4,500
REGIONAL REGRESSIONS (FEMA)	1,803	2,342	2,769	3,231	4,388
WEIGHTED 17B (SIR 2014-5084)	1,490	1,920	2,250	2,610	3,520

Table 2-3 Peak Flow Hydrology for Little Chazy River

Location	Drainage Area (sq. mi.)	Peak Flood Discharge (cfs)			
		10-Year	50-Year	100-Year	500-Year
STA 0+00; At confluence with Lake Champlain	54	1,803	2,769	3,231	4,388
STA 300+00; HRA 1, Hamlet of Chazy	48	1,638	2,561	3,003	4,123
STA 800+00; HRA 2, Hamlet of West Chazy	28	1,484	2,154	2,477	3,236

cfs = cubic feet per second

Stillwater flood elevations on Lake Champlain were gleaned from the 2020 Preliminary FIS for Clinton County (36019CV000B), which are based on statistical analysis of the USGS stage gauge at Rouses Point, New York (4295000). These elevations are summarized in Table 2-4.

Table 2-4 Stillwater Flood Elevations on Lake Champlain for 1929 and 1988 Vertical Datums; May 2011 Record High Elevation Presented for Reference

EVENT	Lake Elevation (ft)	
	NGVD 29	NAVD 88
10-Year	101.43	101.0
25-Year	102.03	101.6
50-Year	102.43	102.0
100-Year	102.83	102.4
May 2011 Record High Elev.	103.2	102.77
500-Year	103.53	103.1

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

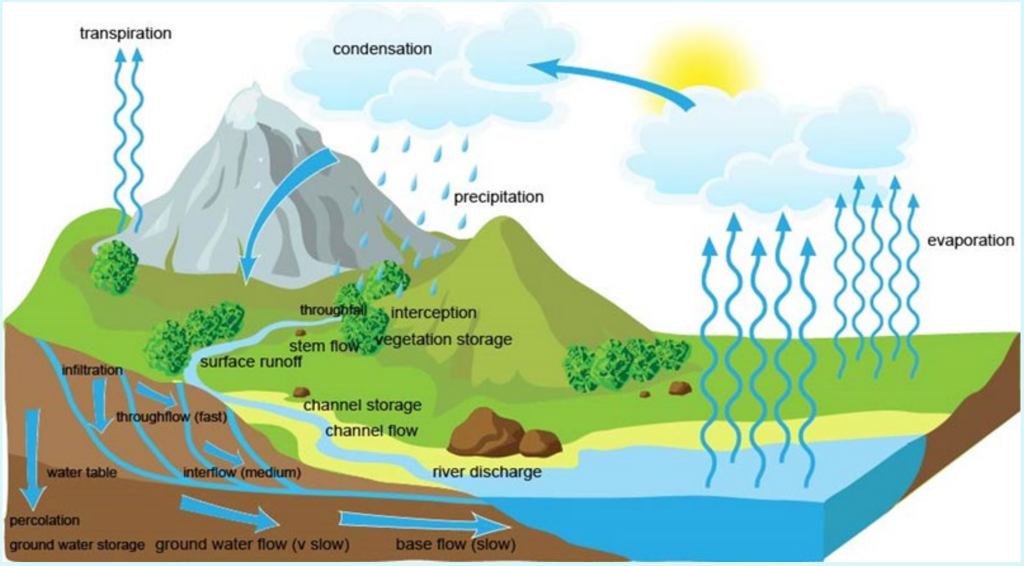

Figure 2-7: Diagram of Simplified Hydrologic Cycle

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 in 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 specific locations along the Little Chazy River, were applied to corresponding design flood flows in the FEMA hydraulic model at the flow change points along the modeled reach of river. The flows based on the more moderate greenhouse gas scenario were used in the model. 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 at the Little Chazy River's confluence with Lake Champlain based on the five climate models are presented in Table 2-5. These are based on regressions for Flood Frequency Region 1 in New York. Projected 50- and 100-year future flows at identified HRAs are presented in Table 2-6.

Table 2-5 Projected Increases in Flood Flows on the Little Chazy River at Confluence with Lake Champlain

Mean Change in discharge (%)	2025-2049		2050-2074		2075-2099	
Greenhouse Gas Scenario	50-Year Flood	100-Year Flood	50-Year Flood	100-Year Flood	50-Year Flood	100-Year Flood
RCP 4.5	9	8	13	13	12	11
RCP 8.5	14	14	14	14	20	19

Table 2-6 Current and Projected Future Flows Used in Hydraulic Analyses at Selected Locations on Little Chazy River

Location	Peak Flood Discharge (cfs)					
	Current		Projected Future (RCP 4.5, 2050-2074)		Projected Future (RCP 4.5, 2075-2099)	
	50-Year	100-Year	50-Year	100-Year	50-Year	100-Year
STA 0+00; Confluence with Lake Champlain	2,769	3,231	3,129 (+13%)	3,651 (+13%)	3,101 (+12%)	3,586 (+11%)
STA 300+00; HRA 1, Hamlet of Chazy	2,561	3,003	2,894 (+13%)	3,393 (+13%)	2,843 (+11%)	3,333 (+11%)
STA 800+00; HRA 2, Hamlet of West Chazy	2,154	2,477	2,456 (+14%)	2,824 (+14%)	2,412 (+12%)	2,774 (+12%)

2.4 HYDRAULICS

One-dimensional HEC-RAS hydraulic modeling of the Little Chazy River developed by FEMA between 2018 and 2019 was obtained from NYSDEC. The river had been partitioned into three discrete approximate methods models, meaning that hydraulic structures such as bridges, culverts, and dams are not surveyed for faithful representation in the model. Within identified flood-prone areas, these features' geometries were field measured and incorporated into the model. The three models were composited into a single complete model of the watercourse and upgraded from HEC-RAS v.5.0.5 to v.6.1 for subsequent analyses.

2.5 PLANNING DOCUMENTS

This assessment utilized existing conditions data and information that was generally publicly available online to identify issues, opportunities, and needs that may be relevant to flood resiliency planning efforts. Sources used for this assessment include the following:

- Floodplain and Flood Hazard Areas utilizing Clinton County GIS & NYS GIS Clearinghouse data
- Google Maps (visual review of existing conditions)
- NYS Property Type Classification Codes – Assessors' Manual (NYS Dept. of Taxation and Finance)
- Town of Chazy, New York Zoning
- Clinton County Multi-Jurisdictional Hazard Mitigation Plan
- Clinton County GIS data
- The Lake Champlain Non-Point Source Pollution Subwatershed Assessment and Management Plan LC Nonpoint Source Pollution Subwatershed Assesment and Mangement Plan Final.pdf (lclgrpb.org)

Relevant planning and zoning information for each identified HRA is located in the respective sections.

2.6 STAKEHOLDER MEETINGS

An important component of the data gathering for this study took place through stakeholder engagement. Three formal stakeholder meetings have been convened by video conference call. The first meeting was held on June 21, 2021, and included NYSDEC Region 5 staff. A second meeting was held on July 29, 2021, and a third on the evening of August 2, 2021, with participation from members of watershed groups, various agencies, and municipalities. In addition to the formal video meetings, many one-on-one conversations took place with representatives from the watershed municipalities and groups.

2.7 INFRASTRUCTURE

Several bridge crossings of the Little Chazy River 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 river but were not assessed in detail generally because they were privately owned, adequately sized, relatively new, or did not significantly increase the flood hazard in surrounding developed areas.

Table 2-7 Bridge Summary Data (limited to bridges in identified HRAs)

Roadway	River Station (feet)	Structure Description	NBI BIN* (Owner)	Year Built	Total Span (ft) (Number of Spans)	Rise Above Streambed (feet)	Bankfull Width (feet) (Regional Regressions)
US-9	250+80	Prestressed concrete	1006030 (State)	1990	61 (1)	16	87
Fiske Road	272+00	Concrete arch	1046260 (County)	1995	36 (1)	11	80
Duprey Road	294+50	Steel multibeam	3336110 (County)	1950	58 (1)		80
Canadian Pacific Railway	768+20	Steel girder	Not Listed	Unknown	16 (1)	10	72
NY-22	779+50	Older masonry arch with newer concrete deck and superstructural elements	Not Listed (State)	Unknown	19 (1)	14	71
CR-25/West Church Street	786+50	Masonry arch	3336190 (County)	1909	28 (1)	10	71

*National Bridge Inventory Bridge Identification Number

Regardless of past bridge performance and flooding history, all replacement stream crossings should be accompanied by rigorous, up-to-date hydrologic and hydraulic analyses and incorporate the most current future flood projections and all applicable design standards and guidance set forth by New York State

Department of Transportation (NYSDOT) and NYSDEC, as practical. Hydraulic design criteria developed by these agencies are presented below and in Table 2-8.

In 2014, the Community Risk and Resiliency Act (CRRA) was signed into law to build New York's resilience to rising sea levels and extreme flooding. The Climate Leadership and Community Protection Act made modifications to the CRRA, expanding the scope of climate hazards and projects for consideration. These modifications became effective January 1, 2020. NYSDEC has provided guidelines for requirements under CRRA, which are summarized in a publication entitled *New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act.*

NYSDOT Hydraulic Design Criteria for Bridges

- **The proposed structure shall not raise the water surface elevations anywhere when compared to the existing conditions for both the 50- and 100-Year flows.**
- **The proposed low chord shall not be lower than the existing low chord.**
- **A minimum of 2.0 feet of freeboard for the projected 50-Year flood is required for the proposed structure. The freeboard shall be measured at the lowest point of the superstructure between the two edges of the bottom angle for all structures.**
- **The projected 100-Year flow shall pass below the proposed low chord without touching it.**
- **The maximum skew of the pier(s) to the flow shall not exceed 10 degrees.**
- **For the purposes of resilient design, current peak flow estimates shall be increased by 10% in DEC Regions 4, 5, and 6, plus Cayuga, Onandoga, Seneca, and Tompkins Counties; in Regions 1, 2, 7, 8, 9, 10, and 11, plus Cortland and Oswego Counties, peak flows shall be increased by 20%.**

Reproduced from Section 3.2.3.1 of 2019 NYSDOT *Bridge Manual*.

Table 2-8 Design Flood Frequencies for Drainage Structures and Channels, Reproduced from Table 8-2 in 2018 NYSDOT *Highway Design Manual Revision 91*

HIGHWAY FUNCTIONAL CLASSIFICATION	DESIGN FLOOD FREQUENCY (YEARS)[1,3]		
	Culverts[2]	Storm Drainage Systems	Ditches[4]
Interstates and Freeways	50	10[5]	25
Principal Arterials	50	10[5]	25
Minor Arterials, Collectors, Local	50[6]	5[7]	10

1. The values in this table are typical. The selected value for a project should be based upon an assessment of the likely damage to the highway and adjacent landowners from a given flow and the costs of the drainage facility. Note: 100-year requirements must be checked if the proposed highway is in an established regulatory floodway or floodplain.
2. The check flow, used to assess the performance of the facility, should be the 100-year storm event.
3. Relocated natural channels should have the same flow characteristics (geometrics and slope) as the existing channel and should be provided with a lining having roughness characteristics similar to the existing channel.
4. Including lining material
5. As per 23CFR650A, and Table 1-1 of HDS 2, a 50-year frequency shall be used for design at the following locations where no overflow relief is available:
    a. sag vertical curves connecting negative and positive grades.
    b. other locations such as underpasses, depressed roadways, etc.
6. A design flood frequency of 10 or 25 years is acceptable if documented in the Design Approval Document, and when identified after design approval, in the drainage report. A design flood frequency of 10 or 25 years should be used in the design of driveway culverts and similar structures.
7. Use a 25-year frequency at the following locations where no overflow relief is available:
    a. sag vertical curves connecting negative and positive grades.
    b. other locations such as underpasses, depressed roadways, etc.

NYSDEC Stream Crossing Guidelines

- **Bridges and bottomless arches are preferred and should be used whenever possible.**

- **Box and pipe culverts, if used, must be:**
  - Embedded into the streambed to at least 20 percent of the culvert height at the downstream end.
  - Used only on streambeds with slopes no steeper than 3 percent.
  - Installed level.

- **The crossing opening should be at least 1.25 times the width of the stream channel bed. This width is measured bank-to-bank at the ordinary high water level or edges of terrestrial, rooted vegetation.**
  - An average of three measurements, at the project location and up- and downstream, should be used to determine the channel bed width.

- **At low flows, water depths and velocities should be the same as they are in natural areas up- and downstream of the crossing.**

- **Natural substrate should be used within the crossing, and it should match the up- and downstream substrates. It should resist displacement during floods and should be designed so that the appropriate material is maintained during normal flows.**

3. IDENTIFICATION OF FLOOD HAZARDS

3.1 FLOODING AND ICE JAM HISTORY

Clinton County has an active history of floods, flash floods, and ice jamming. According to NOAA historical records summarized in the FEMA Discovery Report for the Lake Champlain Watershed, Clinton County has experienced 16 flash floods or flooding events, including lakeshore flooding since 2000. Thirteen of those events occurred from 2007 to 2012. Ice jams typically occur in the springtime and are caused by melting snow and ice that create blockages in a river, effectively producing flooding. Clinton County has experienced 15 ice jam events from 2004 to 2011. Flood and ice jam events in Clinton County and on the Little Chazy River are summarized in Table 3-1.

Table 3-1 The Little Chazy River Flood History

Event type	Areas(s) affected	Date	Notes
Flood/Ice Jam	Champlain	1/19/1996	Warm temperatures combined with high amounts of rainfall caused flash floods throughout the county. Around 7” of rain fell in 12 hours. A State of Emergency was declared, and Governor Pataki proclaimed Clinton County a disaster area. Extensive flooding made hundreds of miles of roads unpassable, and infrastructure was considerably damaged. No deaths were reported, and approximately $4,000,000 in property damages were incurred during this event.
Flash Flood	Plattsburgh, Chazy	7/23/1996	Thunderstorms resulted in flash flooding along Lake Shore Drive and Route 9. Pea-sized hail and downed trees were also reported. $10,000
Flash Flood	Countywide	11/09/1996	Heavy rain resulted in flash floods, consequently damaging numerous roads and bridges. Some bridges were washed out. Several rivers crossed record-level thresholds. Property damage totaled to approximately $23,000,000.
Flash Flood	Beekmantown, Dannemora	6/25/1998	Torrential rain resulted in several roads being washed out. No structures were flooded. $20,000
Flash Flood	Countywide	6/27/1998	Wet soil conditions lead to rapid rise in rivers and streams. Numerous roads were flooded and washed out. Property damage totaled to $2,500,000.

Flash Flood/ Ice Jam	Countywide	2/27/2000	Warm temperatures caused large amounts of snowmelt and runoff. A cold front stalled across New England on February 28, 2000, dropping steady amounts of rain on the area as well. These factors combined resulted in ice jams on the Great Chazy River in Perry Mills and the town/village of Champlain. The river gauge for the Great Chazy River at Perry Mills was around 3' above flood stage. Houses and roads were flooded in the village of Champlain. Route 9 was closed. The flood caused an estimated $75,000 worth of property damage.
Flood	Countywide	6/12/2002	2" to 4" of rain fell on Clinton County due to a stalled frontal boundary. A few roads were closed. Property damage totaled to $20,000.
Flood/Ice James	Champlain	3/07/2004	Ice jams created blockages and caused flooding along the Great Chazy River due to combined rainfall and mild temperatures. A few roads were closed, and property damage totaled to $20,000.
Flood/ Ice Jams	Champlain	3/16/2007	Ice jams caused by snowmelt and rainfall resulted in flooding along the Great Chazy River. Some residents were evacuated from their homes. Property damage totaled to $25,000.
Flash Flood	Dannemora, Mooers	7/28/2007	Several thunderstorms traveled through the region on August 17, 2007, resulting in heavy rainfall. On July 28, 2007, a weak upper low-pressure system drifted across a warm, moist, and unstable airmass across northern New York. Localized rainfall amounts were greater than 3", which produced flash floods. Roads were washed out, and basements were flooded. Approximately $45,000 in property damages occurred.
Flood/ Flash Flood	Altona, Harrigan Corners, Ellenburg	8/04/2010	Extensive rainfall totaling more than 5" fell over the northern Adirondacks for 2 days. Extreme flash flooding made multiple roads impassable, also resulting in widespread damage to those roads. Homes, a motel, general store, and two seasonal RV parks were flooded. In one RV park in Ellenburg, three people were trapped by the flash flood and required rescue. No injuries or deaths occurred. The flash flood caused approximately $750,000 in property damages.

Flash Flood	Countywide	8/28/2011	Tropical Storm Irene traveled through Clinton County on August 28, 2011, and caused extensive damage to the region. An estimated 2” to 4” of rain fell on Champlain Valley, and an estimated 4” to 7” of rain fell on the Adirondacks in southern Clinton County. Flash flooding was widespread throughout the region. Winds were greater than 60 miles per hour (mph) and downed trees, resulting impacted power lines. Agricultural fields were flooded and caused around $1,000,000 in crop damages. In the town of Altona, two fatalities occurred due to a flash flood on the Great Chazy River. Flood stage begins at 9’ on the Great Chazy River at Perry Mills, and the gauge there recorded a crest of 9.5’. Many other evacuations and rescues happened all over the county as emergency responders were called to assist individuals. Damages to roads and homes throughout the county totaled to around $9,500,000.
Flood	Altona, Beekmantown	6/29/2013	Heavy rainfall in the higher terrain of central Clinton County caused flooding of Route 190, the Military Turnpike, closing it from Duley Road to Seymour Road. Flooding also occurred on General Leroy Manor Road, Route 734, and roads in Rand Hill. Property damage totaled to $175,000.
Flood	Champlain, Saranac	4/15/2014	Heavy rainfall and snowmelt combined to produce flooding in the Saranac and Great Chazy Rivers. Local roads were flooded along both rivers. Property damage totaled to $250,000.

3.2 FEMA MAPPING

> 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.

As part of the NFIP, FEMA produces FIRMs that demarcate the regulatory floodplain boundaries. As part of an 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.

The current FIS for Clinton County (36019CV000A) has been effective since September 2007. Effective FIRM panels for the Little Chazy River were produced based on hydraulic modeling completed between 1977 and 2001, depending on the pre-countywide FIS municipal jurisdiction. The effective flood hazard areas delineated by FEMA are mapped in Figures 3-1 through 3-4. A revised Preliminary FIS dated August 2021 has been produced (36019CV001B), which incorporates both detailed and approximate methods hydraulic modeling completed as recently as 2018. 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.

A local Flood Damage Prevention Permit is required to be obtained from the local Floodplain Administrator in communities where floodplain development will occur. This includes construction of buildings, excavation, drilling, paving, installation of generators, aboveground and underground tanks, and storage of materials and equipment. The local floodplain permit should not be issued until all other local, state, or federal permits have been obtained. The NYSDEC is available to assist any community with permitting needs, as requested.

Local floodplain permits are not required of New York State agencies; however, they must develop projects according to 6 NYCRR Part 502. New York State agencies that provide funding for projects must also conduct a Part 502 review.

Should the floodplain extent be reduced or increased because of the projects, communities should request a Letter of Map Revision (LOMR) be submitted to FEMA, especially if structures are removed from the floodplain. Costs for this FEMA application should be considered as part of any grant application submitted since it will increase costs.

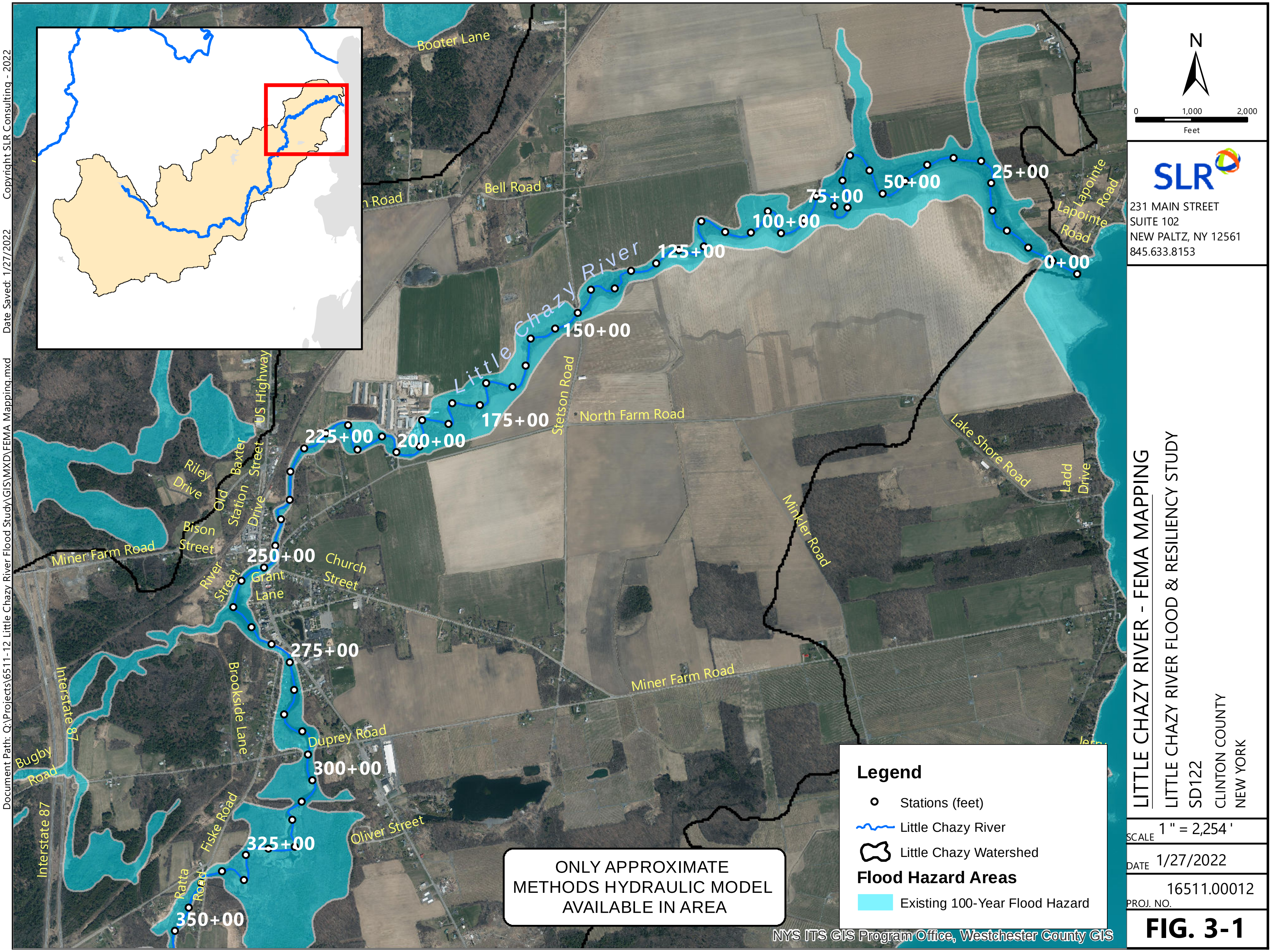
LITTLE CHAZY RIVER - FEMA MAPPING
LITTLE CHAZY RIVER FLOOD & RESILIENCY STUDY
SD122
CLINTON COUNTY
NEW YORK
SLR
231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153
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FIG. 3-1
Legend
Stations (feet)
Little Chazy River
Little Chazy Watershed
Flood Hazard Areas
Existing 100-Year Flood Hazard
ONLY APPROXIMATE METHODS HYDRAULIC MODEL AVAILABLE IN AREA
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Little Chazy River
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Booter Lane
Bell Road
Lapointe Road
Lapointe Road
Stetson Road
North Farm Road
Lake Shore Road
Ladd Drive
Minkler Road
Miner Farm Road
Miner Farm Road
US Highway
Riley Drive
Baxter Street
Old Station Drive
Bison Street
River Street
Grant Lane
Church Street
Brookside Lane
Interstate 87
Interstate 87
Bugby Road
Duprey Road
Oliver Street
Fiske Road
Ratta Road
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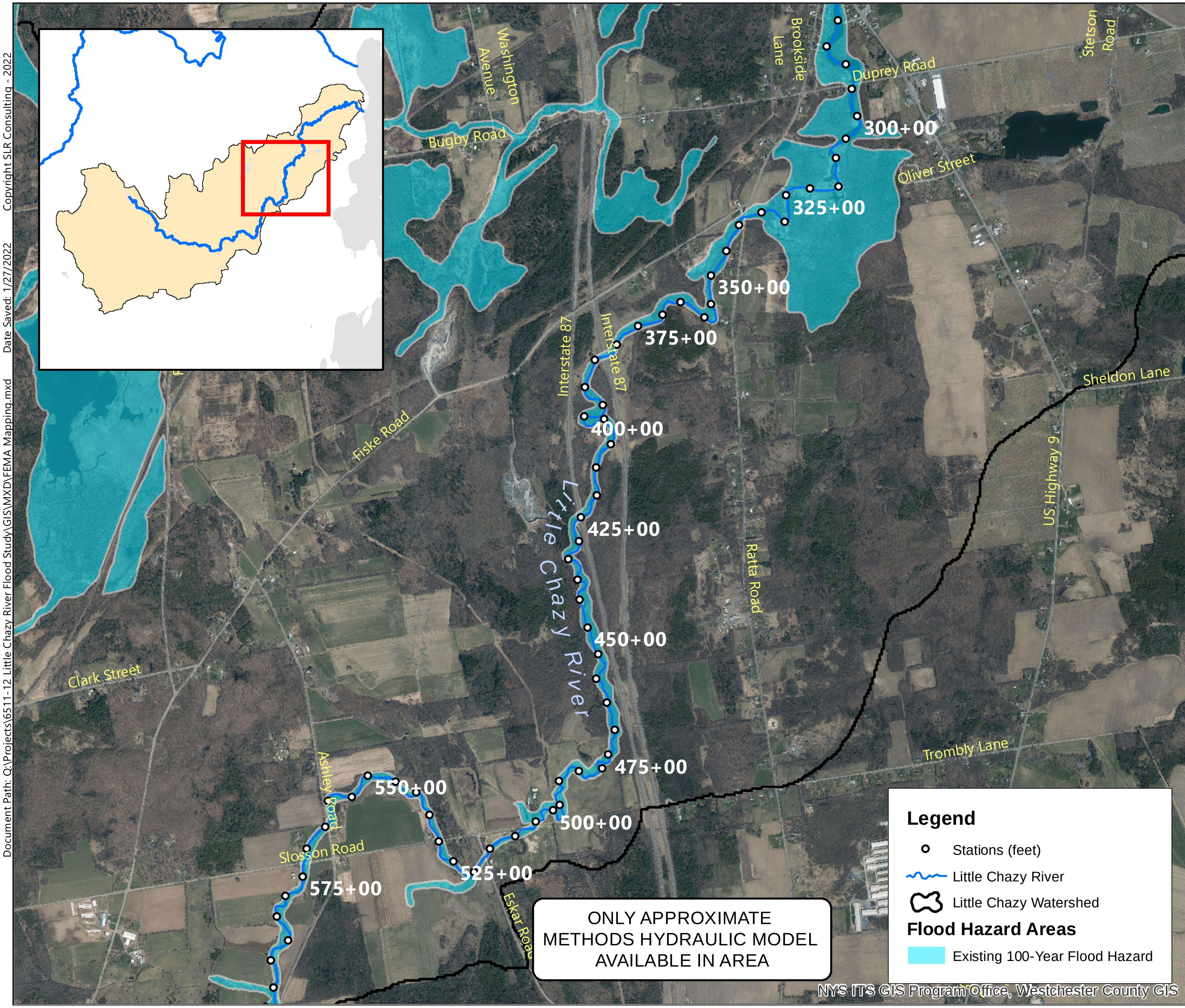

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LITTLE CHAZY RIVER - FEMA MAPPING

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SD122
CLINTON COUNTY
NEW YORK

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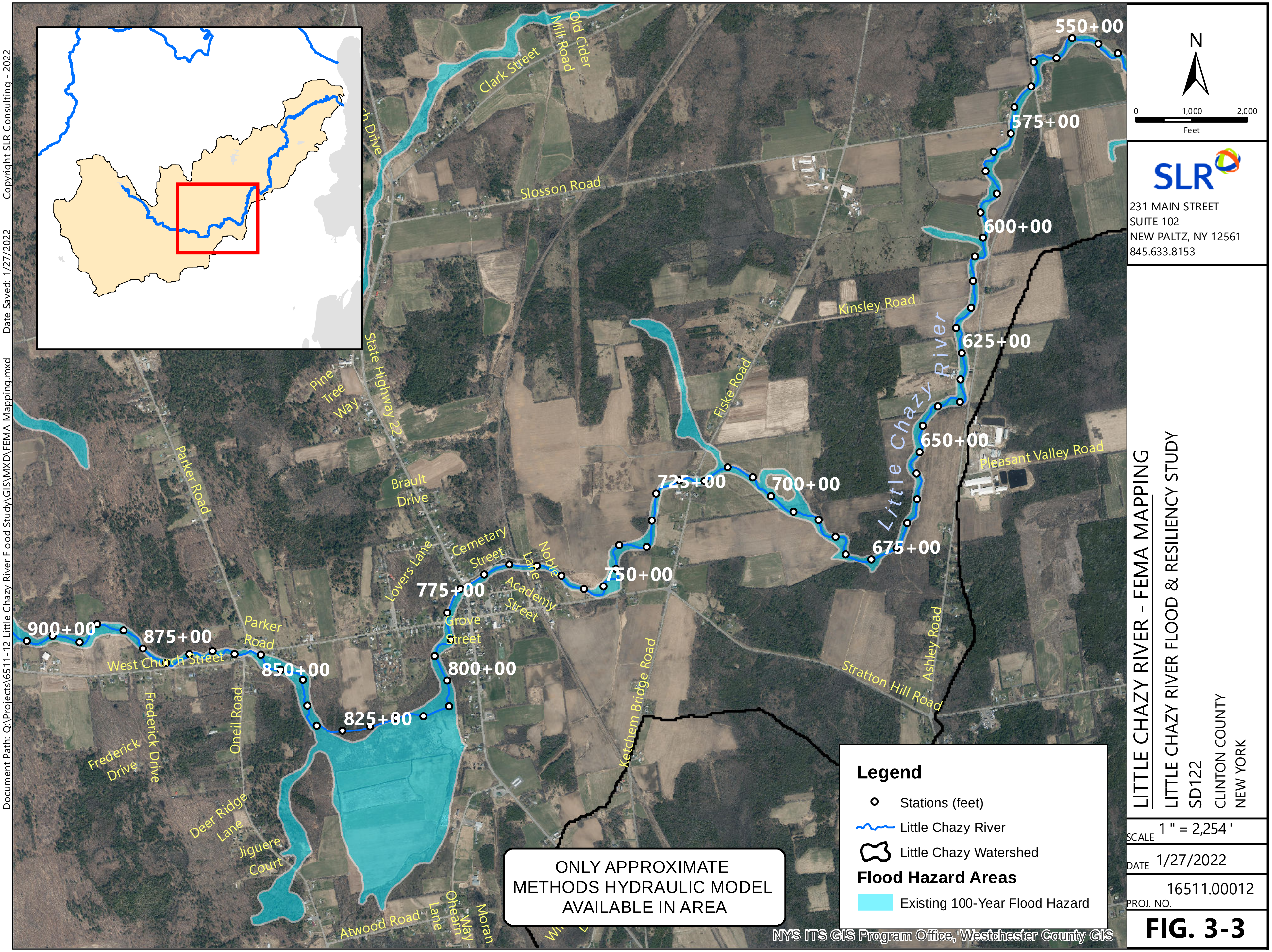
FIG. 3-2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Little Chazy River
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Slosson Road
Kinsley Road
Fiske Road
Pleasant Valley Road
State Highway 22
Pine Tree Way
Brault Drive
Parker Road
Cemetery Street
Lovers Lane
Noble Lane
Academy Street
Grove Street
West Church Street
Frederick Drive
Oneil Road
Deer Ridge Lane
Jiguere Court
Atwood Road
Ohearn Lane
Moran Way
Ketchem Bridge Road
Ashley Road
Stratton Hill Road
ONLY APPROXIMATE METHODS HYDRAULIC MODEL AVAILABLE IN AREA
Legend
Stations (feet)
Little Chazy River
Little Chazy Watershed
Flood Hazard Areas
Existing 100-Year Flood Hazard
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FIG. 3-3
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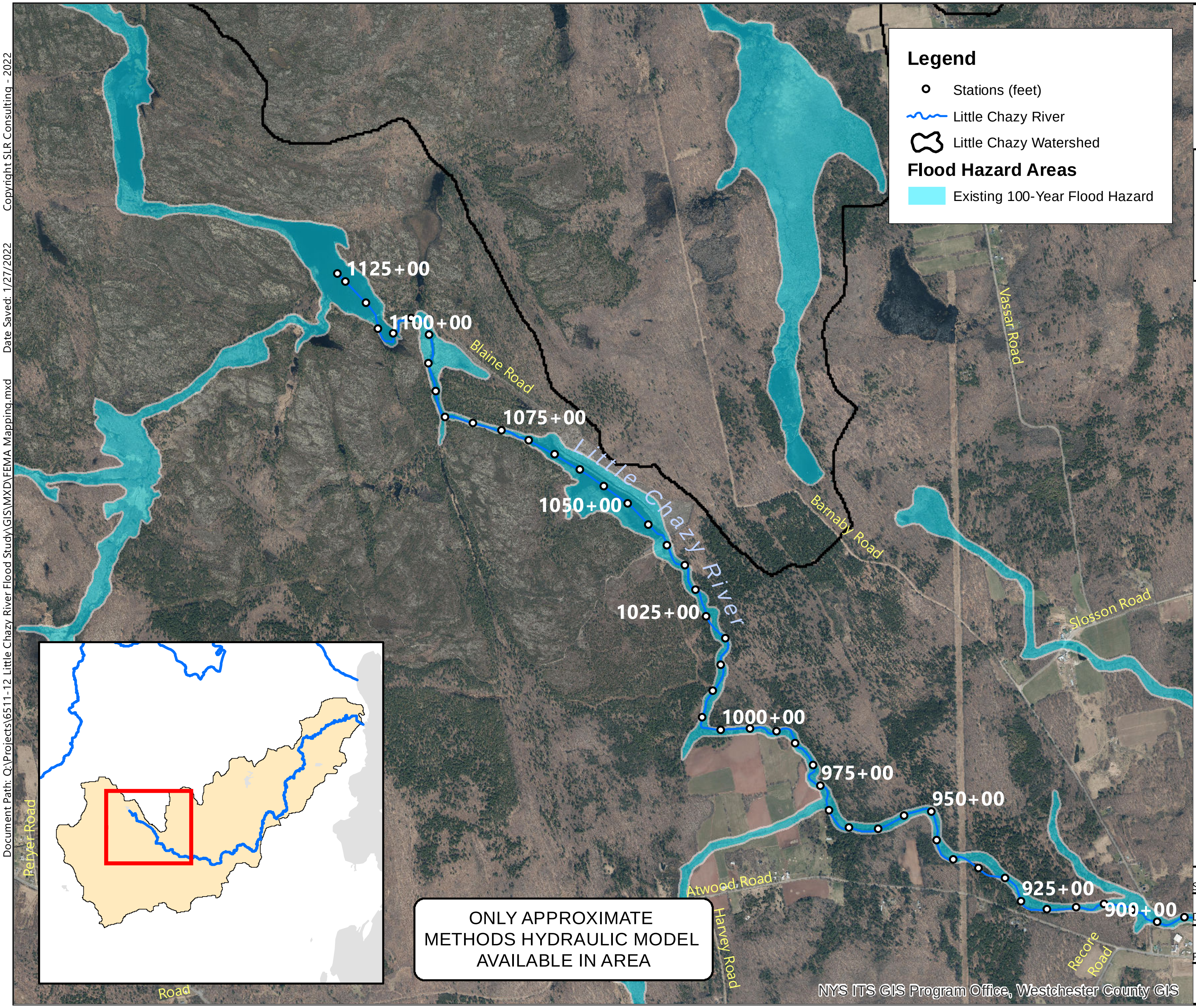

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LITTLE CHAZY RIVER - FEMA MAPPING
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FIG. 3-4

4. FLOOD MITIGATION ANALYSIS

In this section, flood-prone areas within the Little Chazy River watershed are identified, and an analysis of flood mitigation considerations within each HRA is undertaken. HRAs were identified based on comments received during stakeholder meetings; conversations with municipal officials, emergency responders, landowners, and agencies; and through review of FEMA FISs and FIRMs, county Hazard Mitigation Plans (HMP), and other documents. Factors with the potential to influence more than one HRA are also evaluated and discussed. This section also includes analysis and discussion of dams and other structures within the Little Chazy River watershed, including those that do not fall within the HRAs.

Figure 4-1 shows the locations of HRAs within the Little Chazy River watershed.

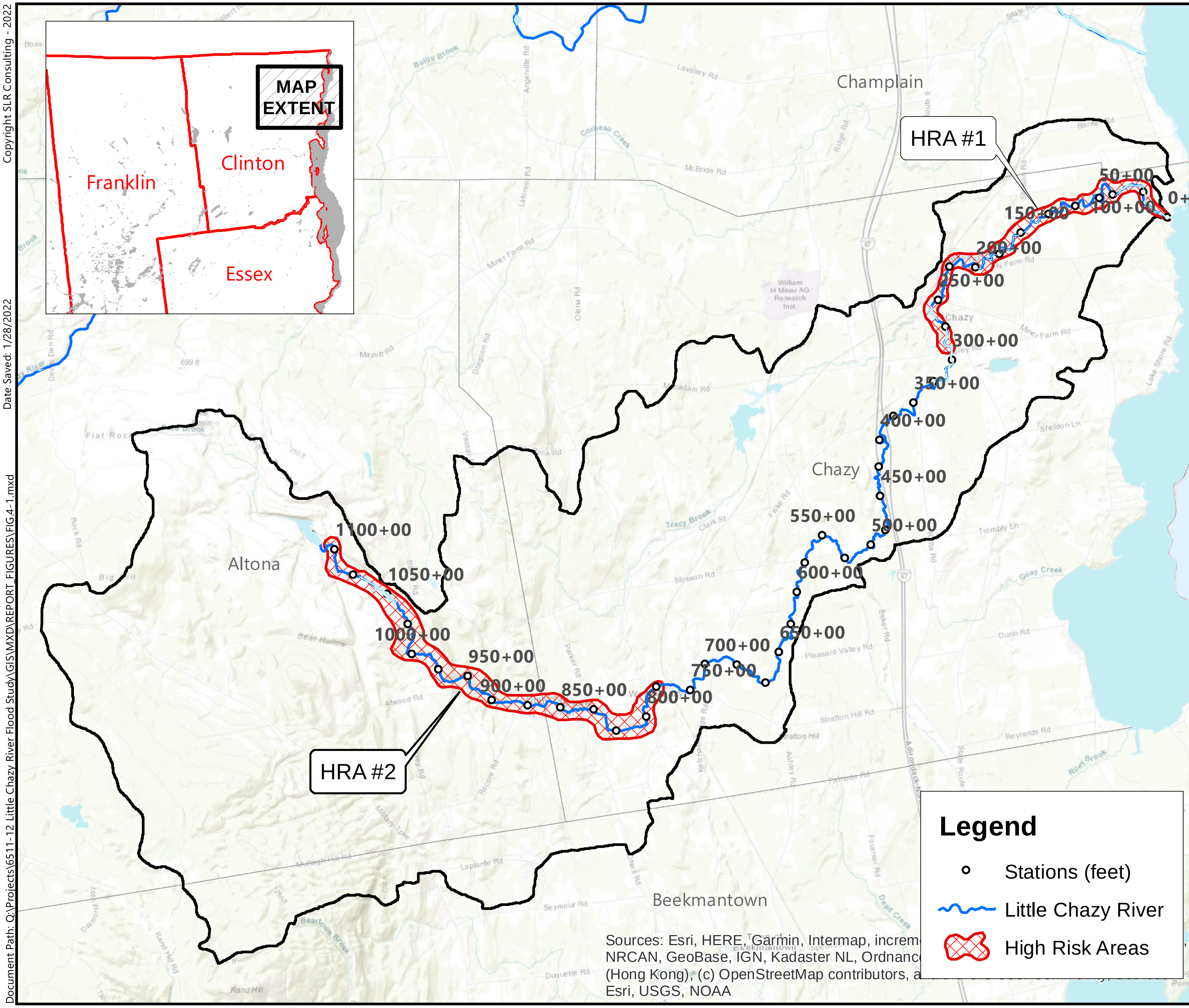
4.1 HIGH RISK AREA #1 – HAMLET OF CHAZY

HRA 1 contains the hamlet of Chazy, extending from Lake Champlain at STA 0+00 to the Duprey Road bridge at STA 295+00 (Figures 4-2A and 4-2B). The state-owned US-9 and county-owned Fiske Road bridge crossings at STA 250+50 and STA 272+00, respectively, were modeled and assessed along with two dams in the hamlet. The hamlet of Chazy is a small, primarily residential area located along State Route 9 just east of the Adirondack Northway (I-87) exit 41 interchange and along both sides of the Little Chazy River as it meanders through the community predominantly in a north-south orientation. Within the study area, the land south of Duprey Road is mostly undeveloped and unutilized. North of the intersection of the road and the river there are many developed properties that are located both along the river and within the floodplain.

The following land use types are found within HRA 1: Tax Classification Codes 100 – Agricultural, 200 – Residential, 300 – Vacant Land, 400 – Commercial, 600 – Community Services, and 800 – Public Services. Flood-prone areas within HRA 1 include residences, apartments, commercial buildings, agricultural land, a cemetery, a public library, government buildings, a recreation facility, an emergency services facility, and public utilities. Critical facilities in the floodplain in HRA 1 include the police/fire station, town hall, library, and wastewater treatment plant.

The Clinton County Multi-Jurisdictional HMP reports that the town of Chazy has two repetitive loss properties and 1,889 structures within the potential loss category. There are 54 structures in the SFHA area (50 with property class code 200 - Residential, one with property class code 300 - Vacant Lands, one with property class code 400 - Commercial, one with property class code 500-Recreation/Entertainment, and one with property class code 800 - Public Service).

The HMP notes the following mitigation projects related to flooding in the town of Chazy: repairing the section of Main Street near the fire station to prevent flooding and washouts, raising a section of LaPointe Road to reduce flooding impacts, maintain/upgrade Miner Dam, and stabilize the banks of Rover's Farm Stream to reduce flooding and erosion.



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LITTLE CHAZY RIVER WATERSHED - HIGH RISK AREAS

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SD122
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NEW YORK

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FIG.4-1

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The Town of Chazy Zoning Law includes ten zones: Hamlet Residential, Hamlet Commercial, Arterial Residential, Commercial, Industrial/Commercial, Rural Use, Lake Area Residential, Lake Area Commercial, Agriculture/Forest, and Conservation. There is a section on green space buffers applying to certain land uses (multifamily dwelling, commercial uses, and industrial uses). There is a section on stream protection that applies to the Little Chazy River and requires that structures be set back at least 50 feet from the mean high water mark of the river, not more than 30 percent of trees in excess of 6 inches diameter at breast height can be removed within 35 feet of the mean high water mark, and no vegetation can be removed within 6 feet of the mean high water mark with the exception of a 30-foot-wide clear area for each lot. There is an exception for removal of diseased or rotten vegetation. Within the conditional use regulations, there is a section about drainage and erosion control, which states "Adequate provision shall be made for drainage of the site, and to ensure that storm water runoff does not create an adverse impact upon nearby lands or waterways." Additionally, junkyards are not allowed within 500 feet of a lake, stream, pond, or wetland. There is a specific section under conditional use regulations on the control of biosludge and waste, which states that "land application of biosolids, sewage sludge, or human-waste-derived products shall not encroach within 100 feet of any floodplain as well as within 100 feet of a stream, river, or other surface water body." Cluster development is permitted by conditional use, and the net buildable site area excludes wetland and flood hazard areas.

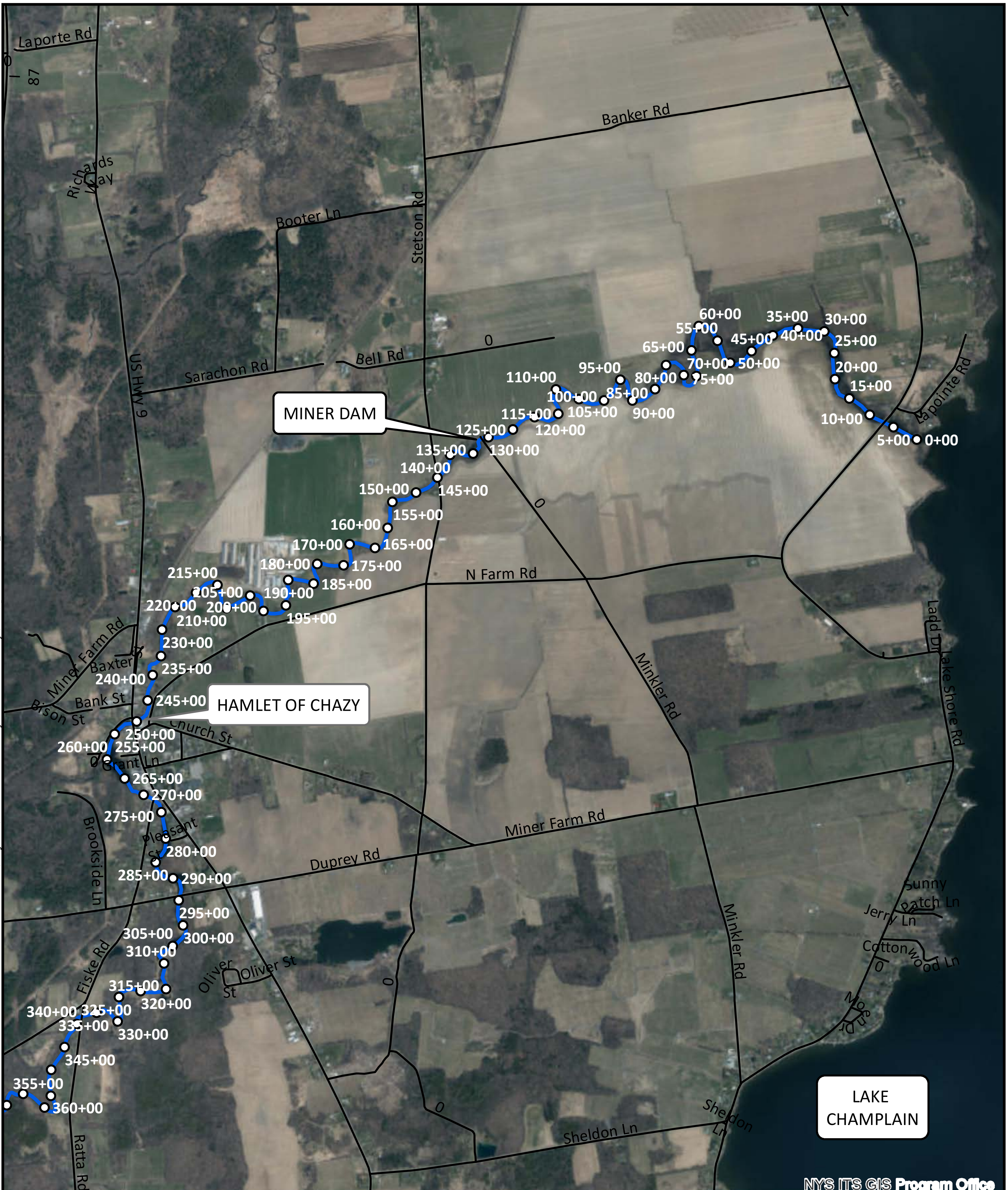
Flooding along the lower reaches of the Little Chazy River is highly influenced by Lake Champlain, which is just under 5 miles downstream of the hamlet of Chazy. The elevation of Lake Champlain fluctuates, with a record low of 92.9 feet NGVD29 (92.47 ft NAVD88) recorded at the Rouses Point USGS gauge (04295000) in October 1941 and a record high of 103.2 feet NGVD29 (102.77 ft NAVD88) in May 2011, which persisted for several weeks. Monthly median lake levels for the portion of this gauge's period of record for which these statistics are available, from WY1939 – WY2020, range from 94.7 feet NGVD29 (94.3 ft NAVD88) in October up to 98.2 feet NGVD29 (97.8 ft NAVD88) in April. Stillwater inundation mapping for Lake Champlain, for stages from 100.0 feet to 106.0 feet (NGVD29), has been rigorously produced by USGS as part of the publication SIR 2018-5169 and mapped in Figure 4-3. The approximate extent of Lake Champlain's backwater on the Little Chazy River at various lake levels is presented in Table 4-1; the lake's tailwaters do not reach above the Miner Dam at STA 132+00.

Table 4-1 Lake Champlain Tailwater Influences (Stillwater Flood Elevations from 2020 Preliminary FIS for Clinton County)

LAKE LEVEL (FT)		NOTE	APPROXIMATE EXTENT OF TAILWATER ON LITTLE CHAZY RIVER (STA)
NGVD 29	NAVD 88		
92.9	92.47	October 1941 record low elev.	
94.7	94.3	October median elev.	73+70
98.2	97.8	April median elev.	131+00
101.43	101.0	10-Year stillwater flood elev.	132+00 (Miner Dam)
102.03	101.6	25-Year stillwater flood elev.	132+00 (Miner Dam)
102.43	102.0	50-Year stillwater flood elev.	132+00 (Miner Dam)
102.83	102.4	100-Year stillwater flood elev.	132+00 (Miner Dam)
103.2	102.77	May 2011 record high elev.	132+00 (Miner Dam)
103.53	103.1	500-Year stillwater flood elev.	132+00 (Miner Dam)

The Miner Dam, located at STA 132+00, is a Class D, Negligible or No Hazard concrete gravity dam constructed in 1926. Its listed owner is the late William H. Miner (1862-1930) (NYSDEC ID: 235-0280; Federal ID: NY14002). The dam's last reported inspection was in 1971. The dam is listed as being originally constructed to provide hydroelectric power although aerial imagery reveals that the impoundment has been substantially filled with sediment, and no evidence of active power generation is visible. The USGS gauging station on the Little Chazy River is located about 0.2 miles upstream of this dam; in the station remarks, the dam is reported to be abandoned. The Miner Dam has a small impoundment and does not contribute to flooding of upstream developed areas, so its operation as a sea lamprey barrier is apparently appropriate, assuming it is maintained in good condition. While the existing structure restricts sea lamprey passage, this ecological objective may be achieved with a far less imposing barrier than this dam's reported 15-foot-tall spillway crest height; a hydraulic drop of 2.2 feet (Katopodis et al., 1994), or 1.5 feet if overhanging (GLFC, 2014; Reinhardt et al., 2009), is sufficient. Exclusion may also be achieved by flow velocities over 13 feet per second (fps) (Hanson, 1980). Sea lamprey barrier criteria are discussed further in Section 4.3.1. Modification of this dam to reduce the spillway elevation to this height, or replacement with a new structure designed specifically for lamprey exclusion, is recommended.

The Fordhams Mills Dam is listed in the NYSDEC inventory as a Class A Low Hazard, 20-foot-high earth and concrete gravity dam (NYSDEC ID: 235-0080; Federal ID: NY14349). The dam is mapped as being located at about STA 150+00, although no structure was observed at this location in historical or modern aerial imagery. However, a dam was observed roughly 4,000 feet to the southwest at STA 198+00. It is understood that dam locations in the DEC inventory are approximate, but this is significantly farther than the typical margin of error seen elsewhere in the watershed, so it is not known whether this is the Fordhams Mills Dam or a different, uninventoried dam. It is recommended that this database entry be verified for accuracy and updated as necessary.



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NEW PALTZ, NY 12561
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HRA #1 - HAMLET OF CHAZY
LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

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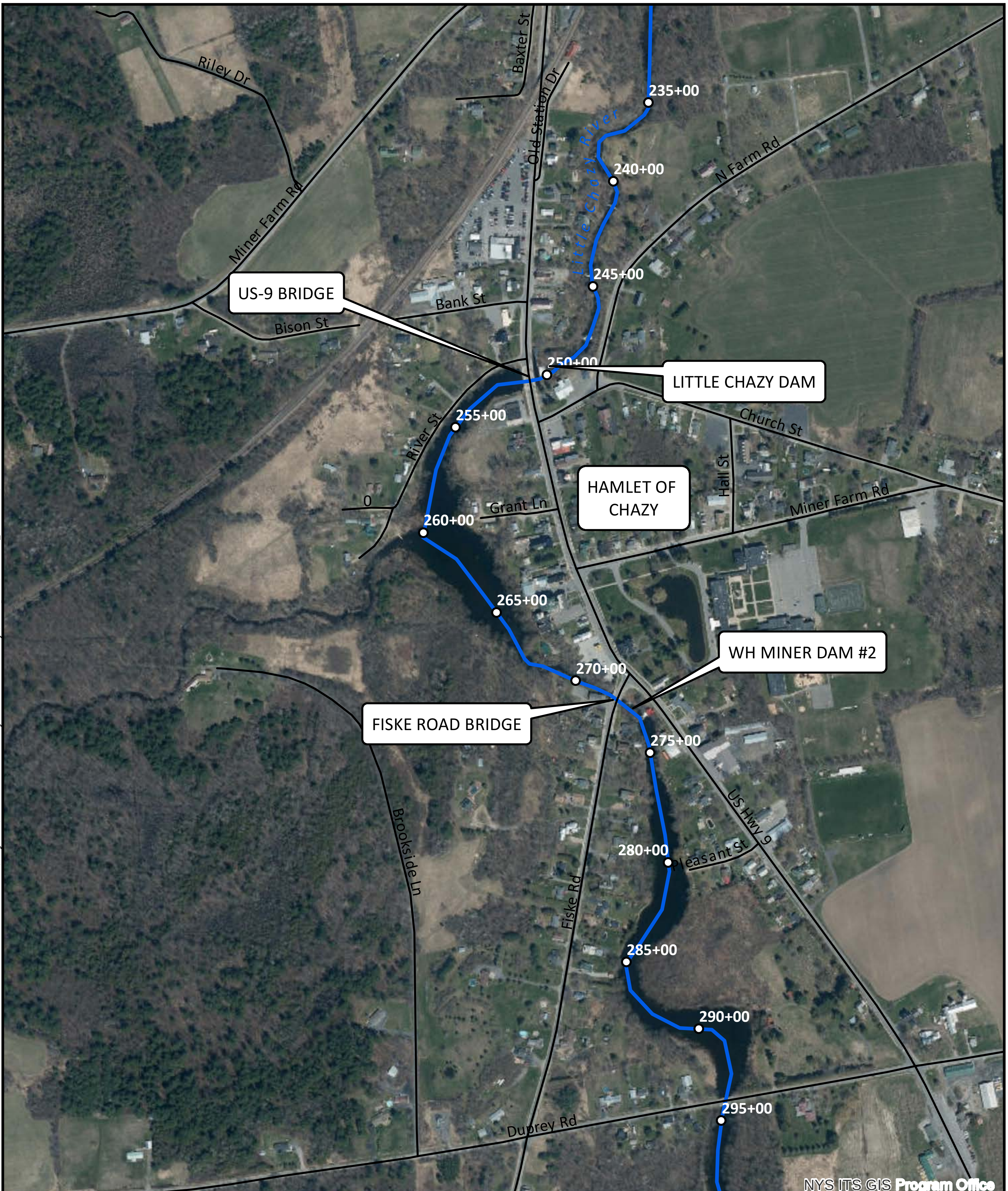
FIG. 4-2A



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HRA #1 - HAMLET OF CHAZY

LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

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FIG. 4-2B

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HRA #1 - HAMLET OF CHAZY
LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

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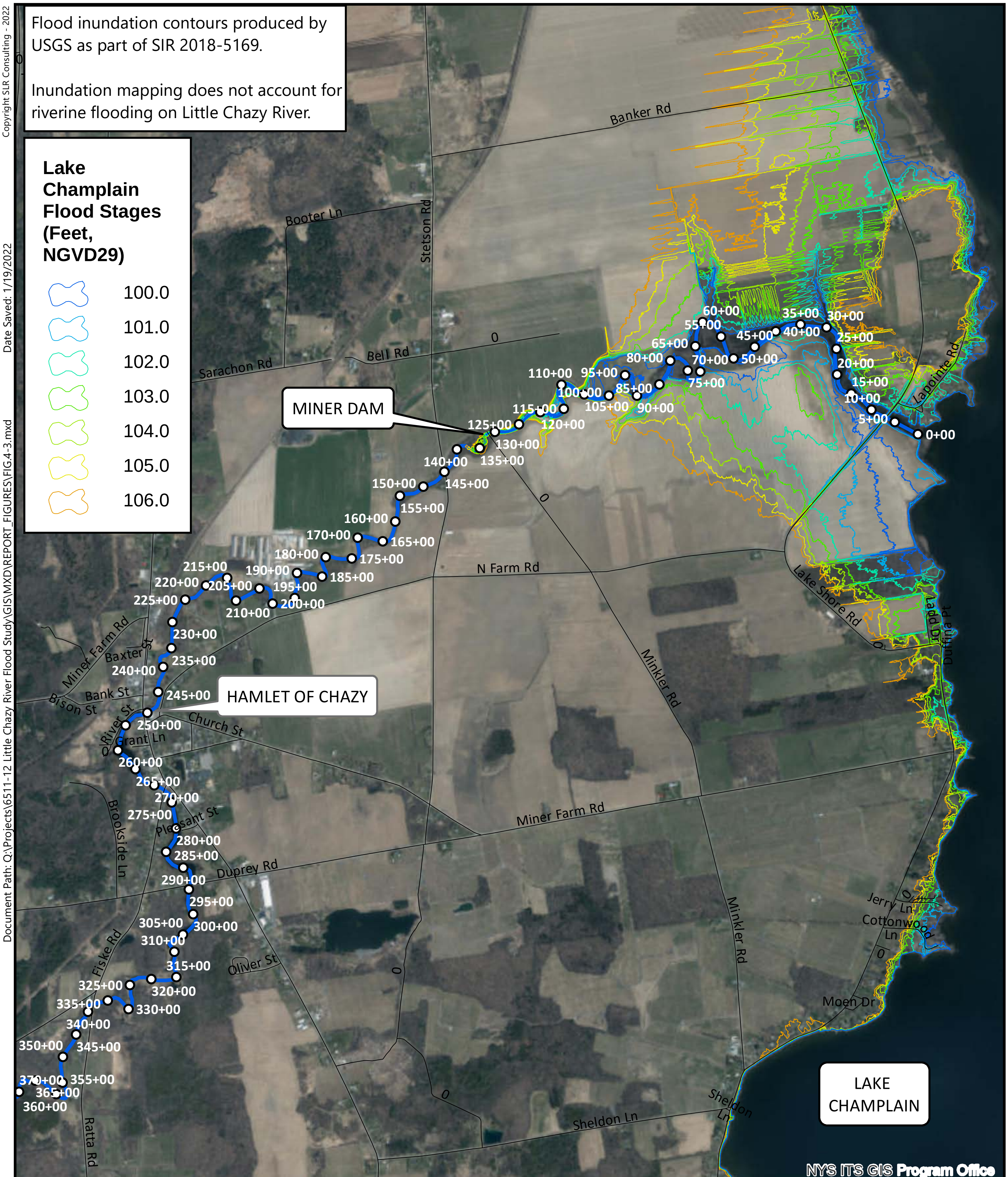
FIG. 4-2C



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HRA #1 - LAKE CHAMPLAIN STILLWATER FLOODING
LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

N
0 1,500
Feet

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DATE 1/19/2022
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PROJ. NO.
FIG. 4-3

The Little Chazy Dam (Figures 4-4 and 4-5) sits just under 20 feet downstream of the downstream face of the US-9 bridge over the Little Chazy River in the town and hamlet of Chazy at STA 250+50 (NYSDEC ID: 235-0097; Federal ID: NY13995). This 18-foot-high, Class A Low Hazard concrete gravity dam was constructed in 1909 to provide hydroelectric power. It is presently owned by the Chazy Fire District; the fire station is located adjacent to the dam, depicted in Figure 4-2C, although the impoundment is reportedly no longer the district's primary water supply for firefighting. The last reported inspection was in 1971. During normal flows, this dam's impoundment reaches about 1,600 feet upstream, which can contribute to ice formation during the winter months that can exacerbate the severity of downstream ice jams, although problematic ice jamming was not reported in the Hamlet. During high flow events, the dam's backwaters contribute to flooding of 16 homes and businesses during the 10-year flood event, with a further 12 properties impacted during the 100-year flood event. Both 10-year and 100-year flood events cause overtopping of US-9 and River Street. It should be noted that neither the current effective nor preliminary FIS products appear to account for the presence of this dam; approximate methods hydraulic modeling associated with the 2020 Preliminary FIS does not include the structure. As a result, 100-year flood elevations in the hamlet upstream of the dam are underestimated by about 3 feet to over 5 feet compared to updated modeling developed for this study that does incorporate the dam.

Figure 4-4: View of Little Chazy Dam primary spillway from US-9 bridge. Chazy Fire District building is visible in background, partly obscured by vegetation.

Figure 4-5: US-9 bridge, right training wall of Little Chazy Dam in foreground

The US-9 bridge at STA 250+20 (NBI BIN: 1006030) is currently undersized for flood flows due to the backwater influence of the Little Chazy Dam just downstream. Dam removal was simulated in the hydraulic model developed for the Little Chazy River. Under this scenario, 100-year water surface elevation at the US-9 crossing is reduced by 10.7 feet, eliminating pressurized flow through the bridge, which would then have over 9 feet of freeboard to its low chord during the 100-year flood event. The bridge would have over 8 feet of freeboard in the 500-year flood event and the projected future 100-year flood event. Moreover, all homes, businesses, and roadways currently modeled as flood-prone due to the dam would no longer be inundated in assessed floods, including the projected future 100-year flood event and the current 500-year flood event. Because of the dramatic flood mitigation benefits that can be achieved, as well as the elimination of an ice formation location, removal of the Little Chazy Dam is recommended as a priority. An accompanying structural assessment of the US-9 bridge is necessary to determine whether dam removal will generate adverse scour conditions at the bridge. If necessary, installation of an alternative means of water withdrawal for fire suppression is recommended such as the typical dry hydrant detail shown in Figure 4-35.

Roughly 300 feet upstream of the head of the Little Chazy Dam's normal impoundment, about 150 feet upstream of the Fiske Road bridge, sits W. H. Miner Dam #2 at STA 273+50 (NYSDEC ID: 235-0103; Federal ID: NY13996). This Hazard Class A, 11-foot-high earth and concrete gravity dam was constructed for hydroelectric power in 1909 and was reportedly last inspected in 1971. The dam, pictured in Figures 4-6 and 4-7, is currently owned by the Chazy Fire District. The river profile is particularly flat upstream of this dam such that the influence of the impoundment extends almost 1 mile upstream during normal flow conditions. As such, the dam is assessed as contributing to excess wintertime ice accumulation. Under flood scenarios, modeling indicates that the dam's backwater causes flooding of six homes and businesses and inundation of Fiske Road during the 10-year flood event, with an additional five properties affected by the 100-year flood, which also overtops Duprey Road to the south. The 10-year flood also overtops the left training wall and top of dam, indicating a hydraulically undersized spillway and potential exposure to loadings in excess of design, both of which can increase the risk of dam failure.

Figure 4-6: The W.H. Miner Dam #2 in West Chazy. Note deteriorated concrete spillway and powerhouse building.

Figure 4-7: Spillway of the W.H. Miner Dam #2 in West Chazy

Removal of the W. H. Miner Dam #2 was simulated, which alleviates flooding of these buildings and roads in these events. There are additional flood-prone properties along Duprey Road and farther south on Fiske Road, although this is a product of the stream's very shallow gradient along this reach more than the dam's influence. Because of the flood mitigation benefits that can be achieved, as well as the elimination of a potential ice formation location, removal of the W. H. Miner Dam #2 is recommended. If necessary, installation of an alternative means of water withdrawal for fire suppression is recommended such as the typical dry hydrant detail shown in Figure 4-35.

Figure 4-8 depicts flooding depths and extents within HRA 1 during the 10-year flood event under existing conditions. Figure 4-9 depicts the same area during the 10-year flood event with both the Little Chazy Dam and the W. H. Miner Dam #2 removed. Figure 4-10 depicts HRA 1 during the current 100-year flood event and the future 100-year flood event under existing conditions. Figure 4-11 depicts HRA 1 during the current and future 100-year flood events with both dams removed. Figure 4-12 is a longitudinal profile showing flood elevations during the 10-year flood event and the current and future 100-year flood events under existing conditions and with the two dams removed.

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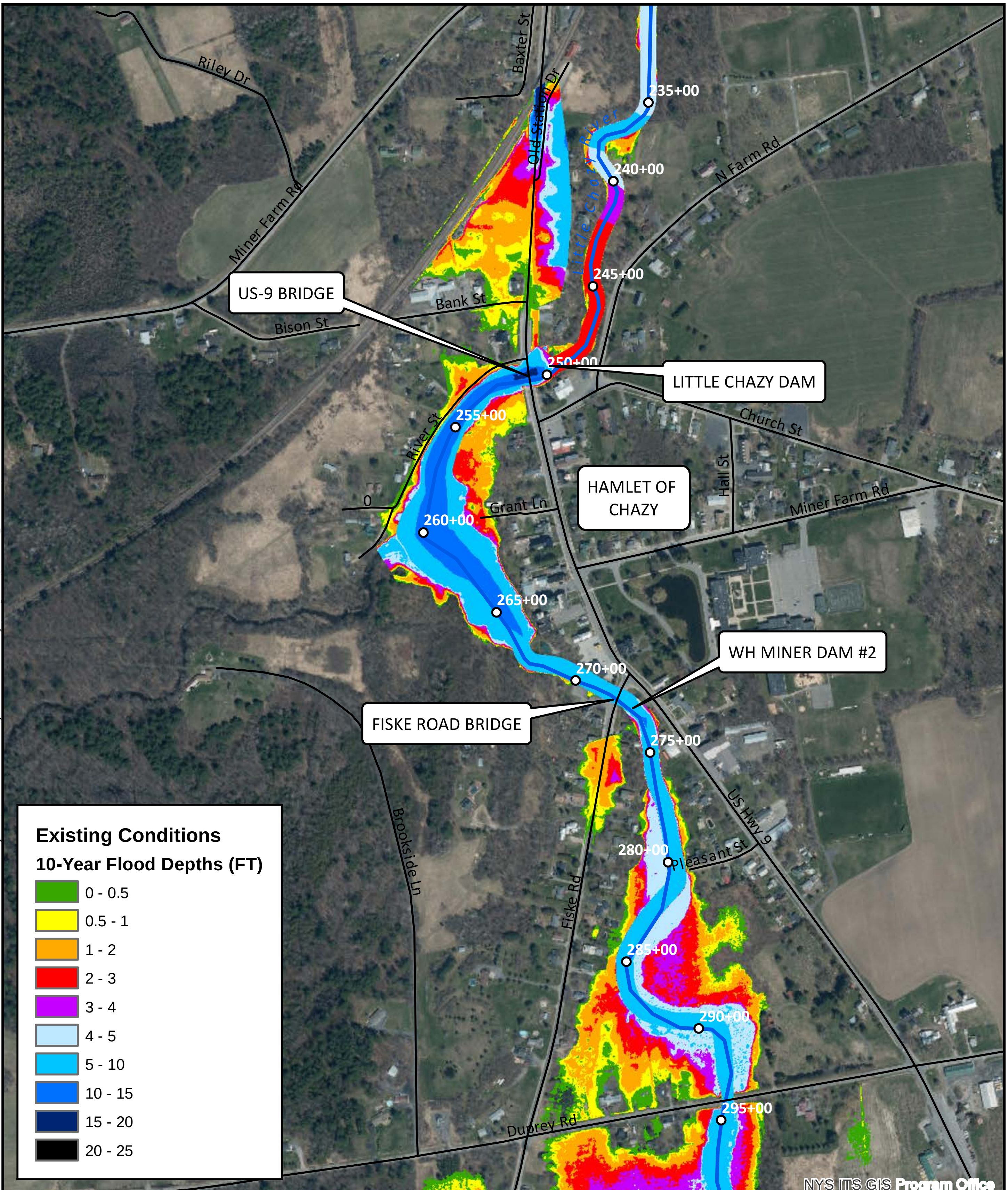

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HRA #1 - EXISTING CONDITIONS 10-YEAR FLOOD
LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

N
0 500
Feet

SCALE 1 " = 600 '
DATE 1/19/2022
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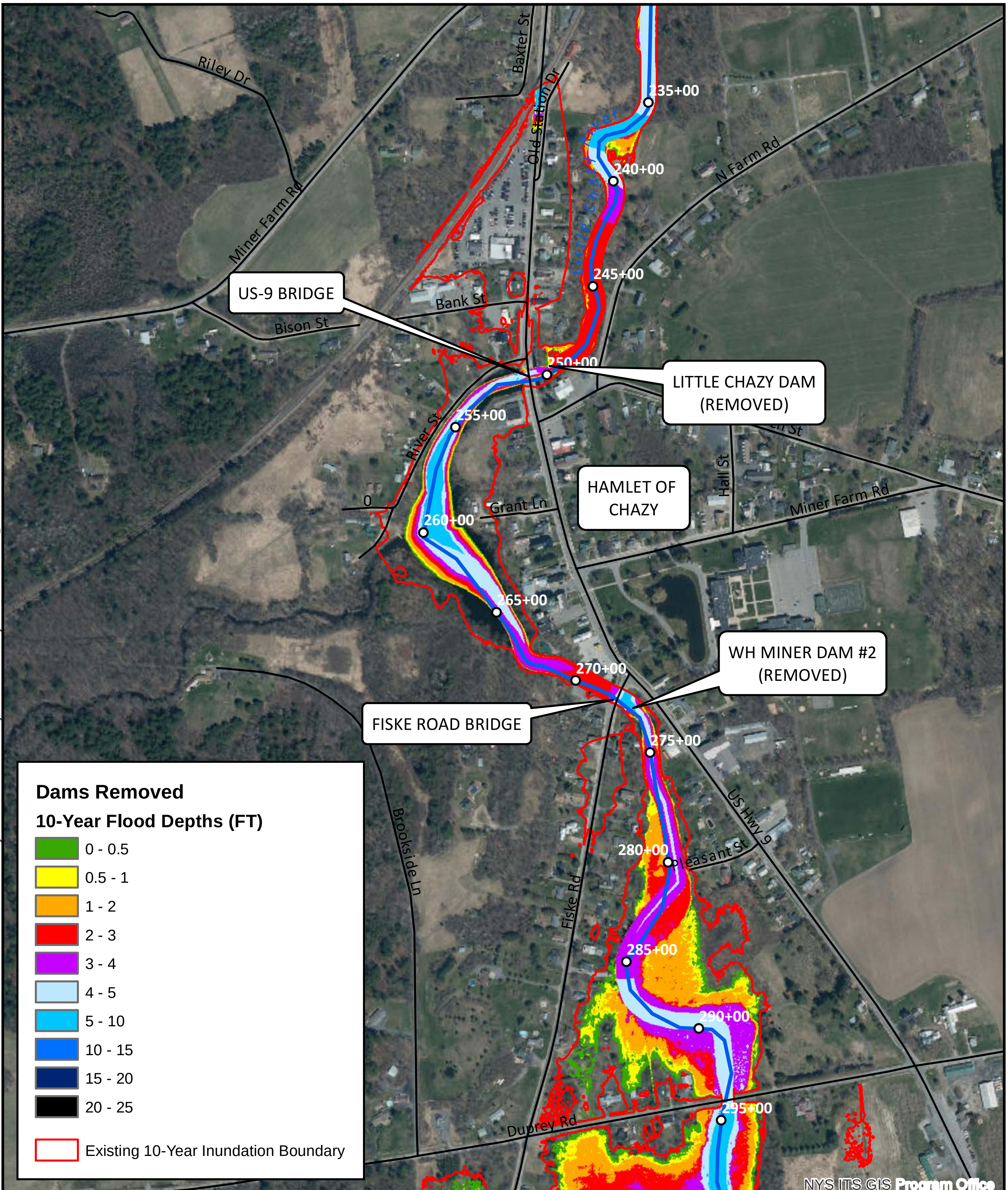
FIG. 4-8



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HRA #1 - DAMS REMOVED - 10-YEAR FLOOD

LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

N
0 500
Feet

SCALE 1 " = 600 '
DATE 1/19/2022
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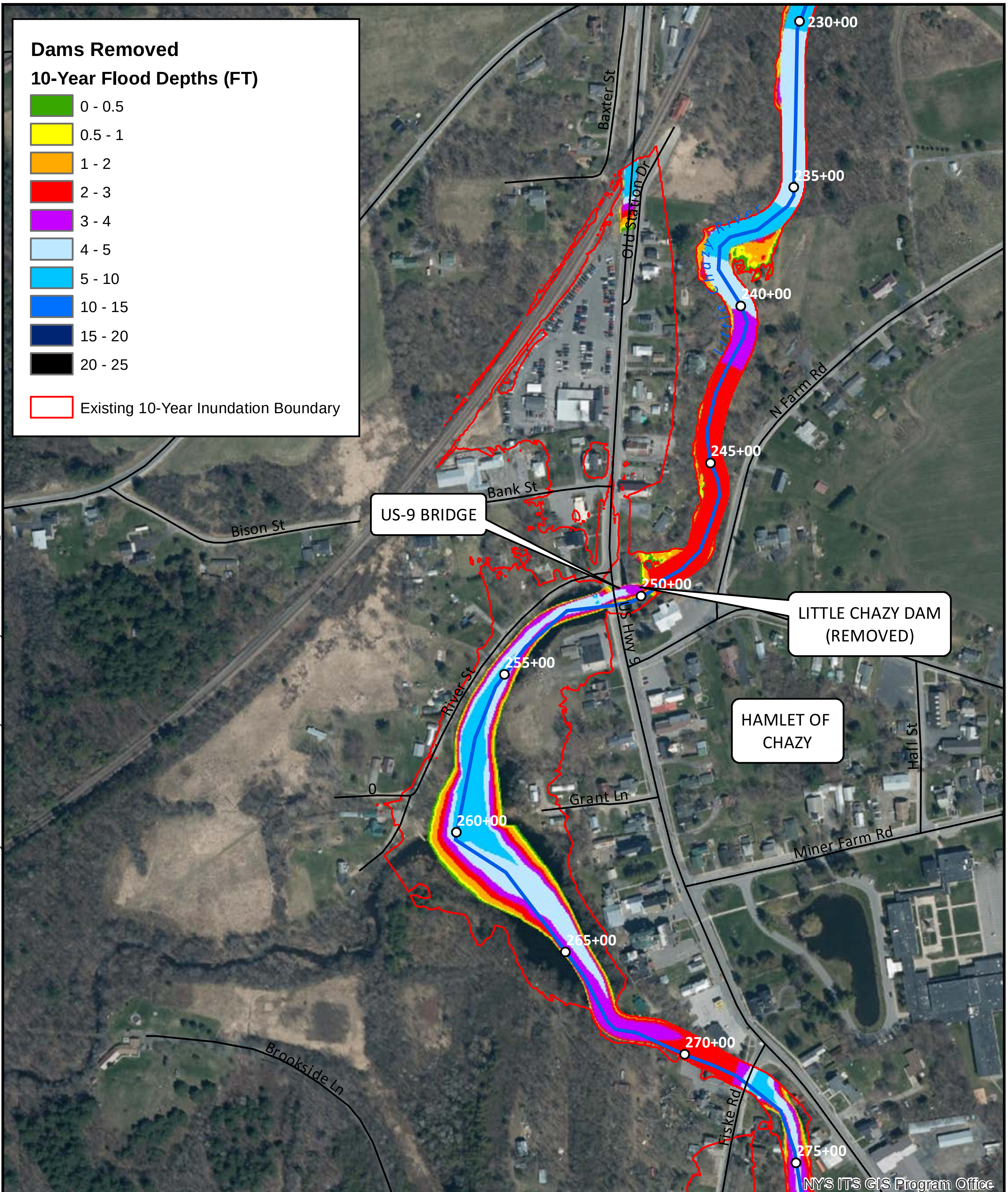
FIG. 4-9



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HRA #1 - DAMS REMOVED - 10-YEAR FLOOD
LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

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SCALE 1 " = 400 '
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FIG. 4-9B

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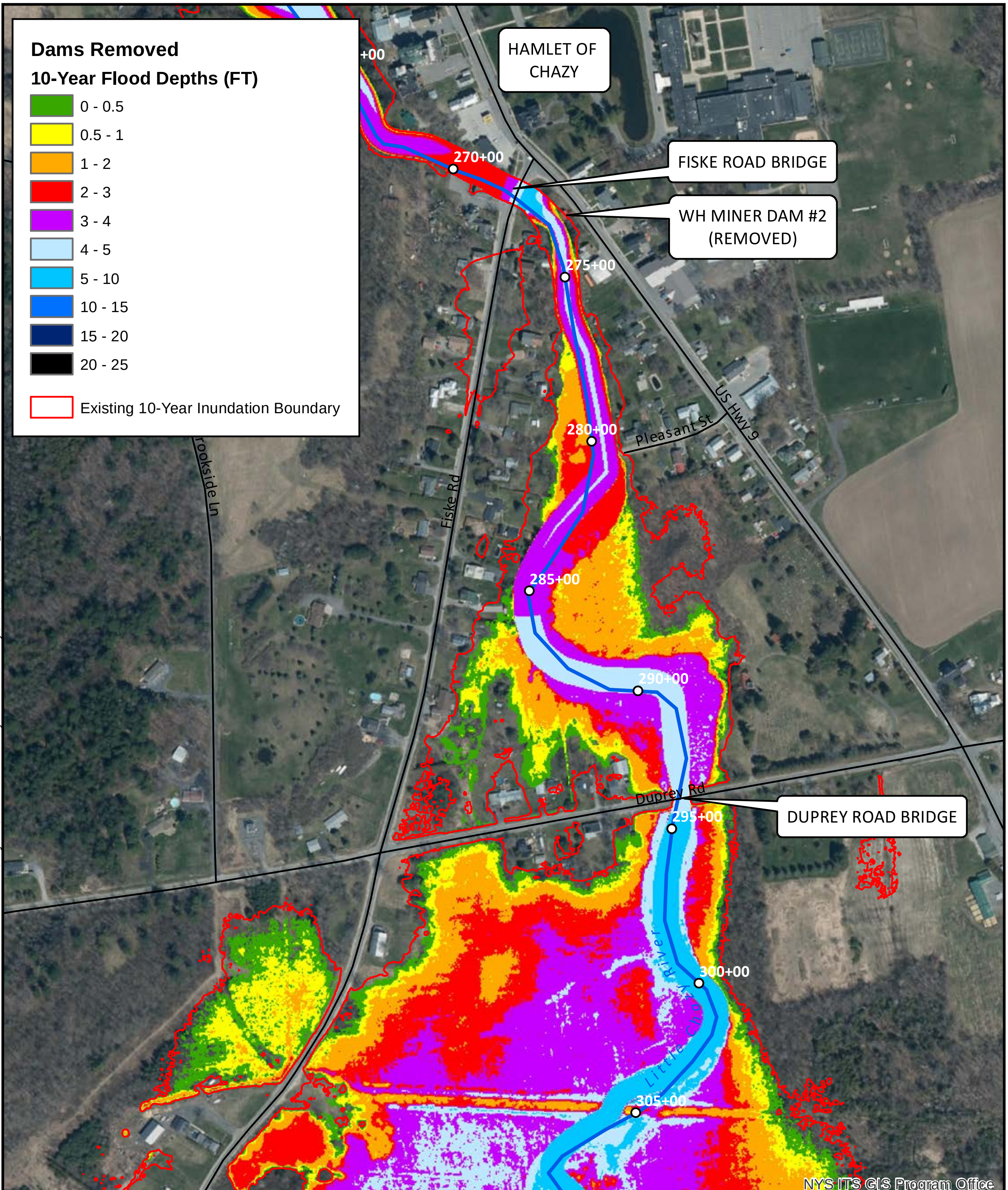

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HRA #1 - DAMS REMOVED - 10-YEAR FLOOD
LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

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SCALE	1 " = 400 '
DATE	4/7/2022
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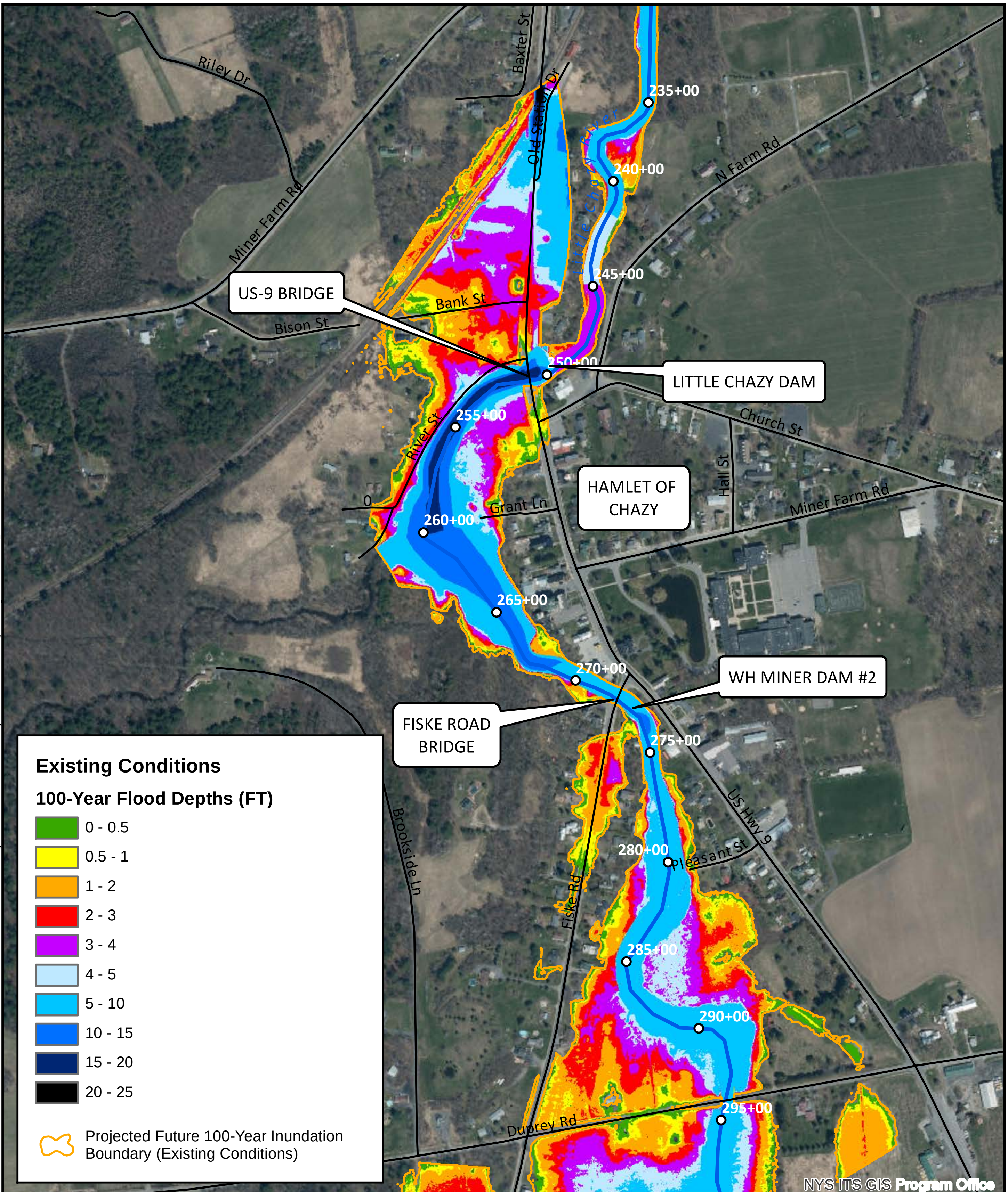
FIG. 4-9C



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HRA #1 - EXISTING CONDITIONS 100-YEAR FLOOD

LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

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FIG. 4-10

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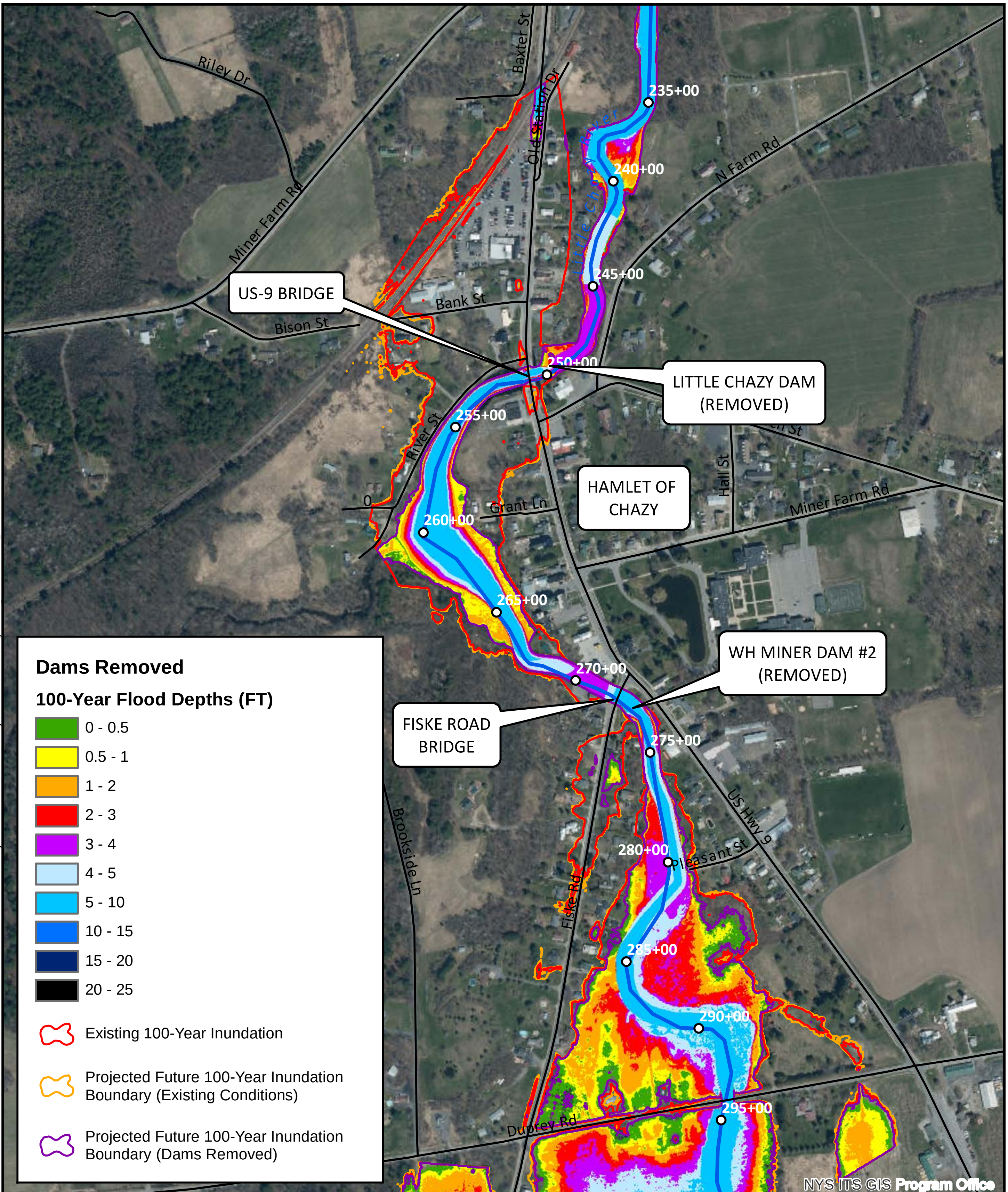

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HRA #1 - DAMS REMOVED - 100-YEAR FLOOD

LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

SCALE	1 " = 600 '
DATE	1/21/2022
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FIG. 4-11

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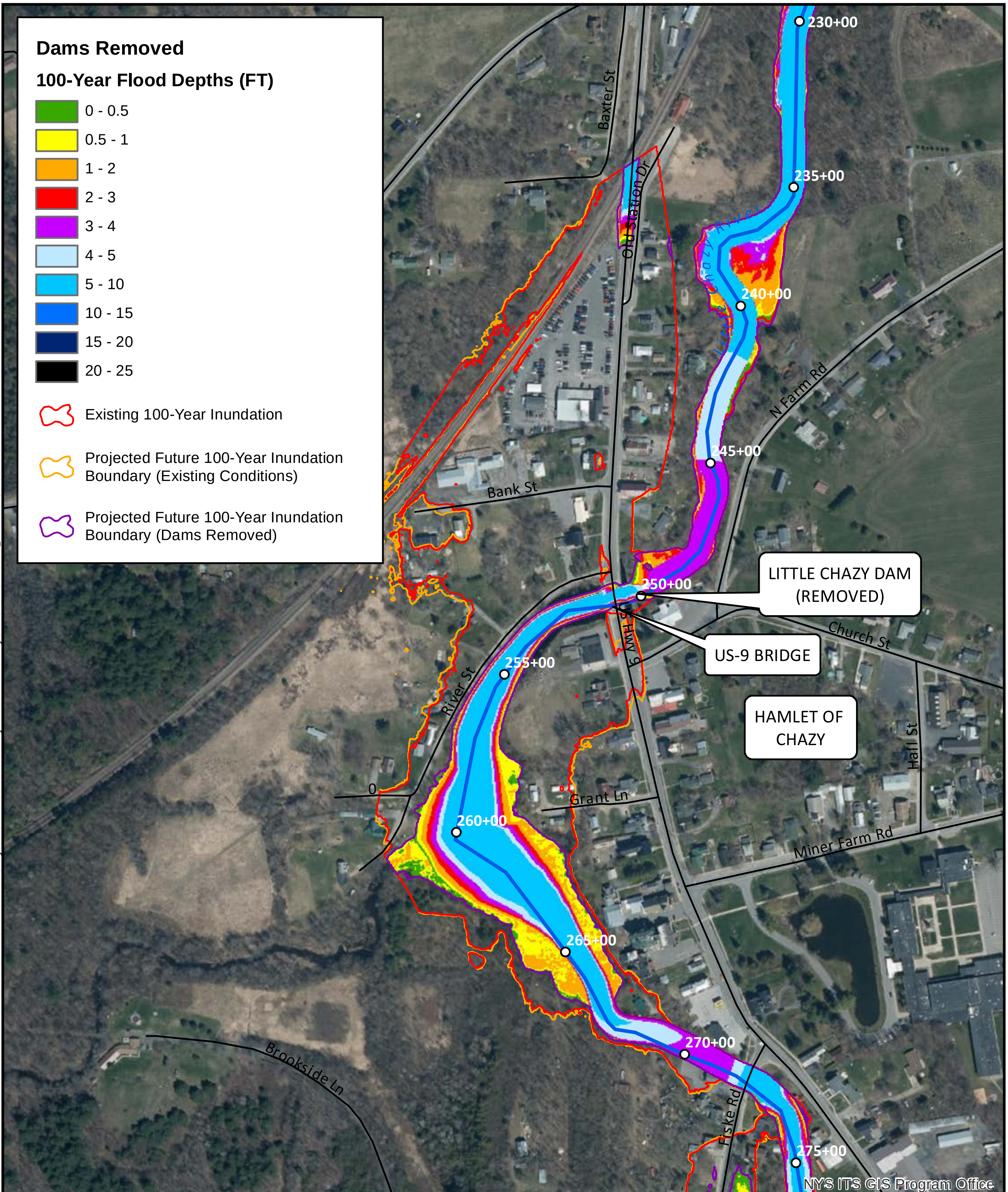

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HRA #1 - DAMS REMOVED - 100-YEAR FLOOD
LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

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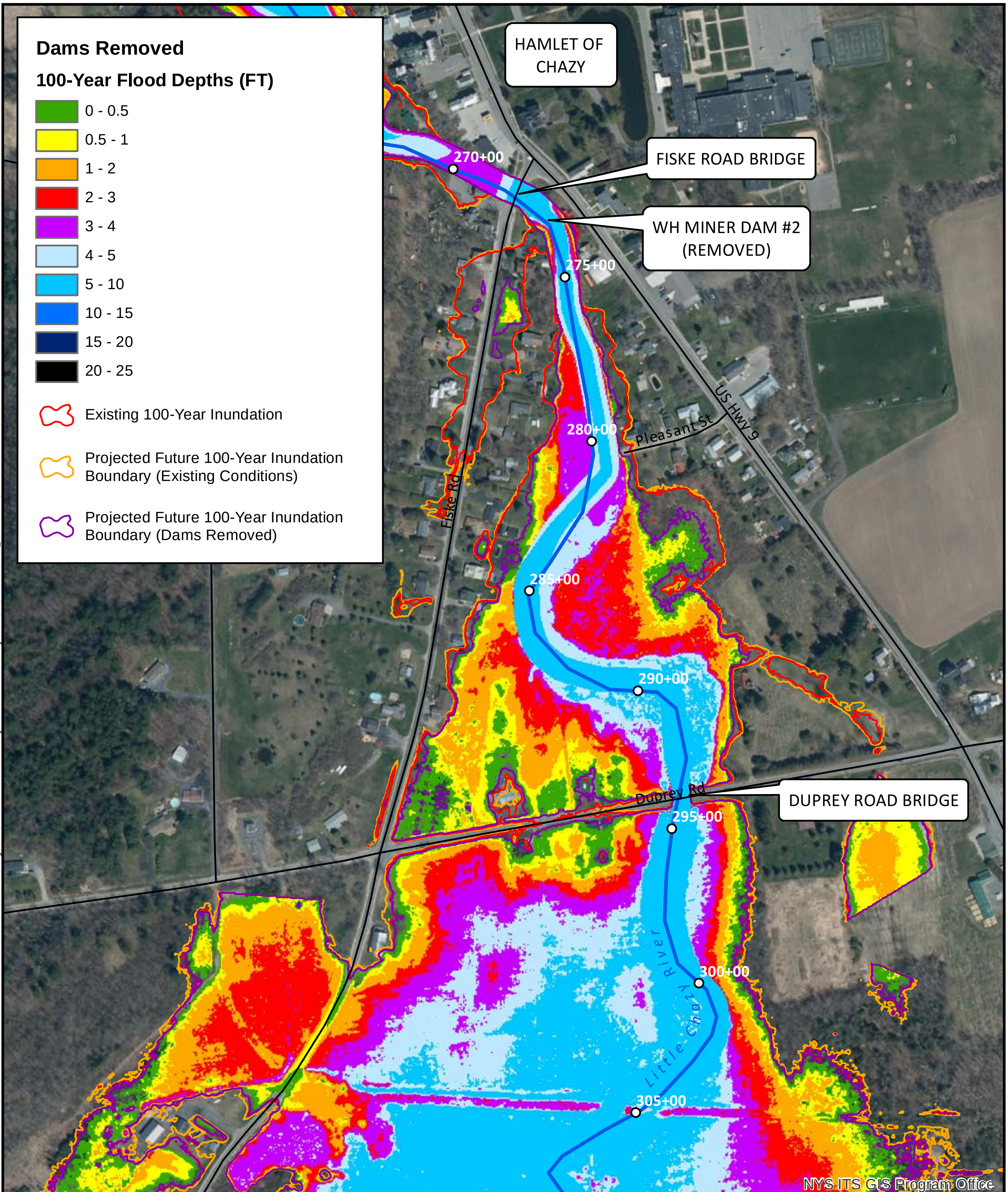
FIG. 4-11B



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HRA #1 - DAMS REMOVED - 100-YEAR FLOOD

LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

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DATE 4/7/2022
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FIG. 4-11C

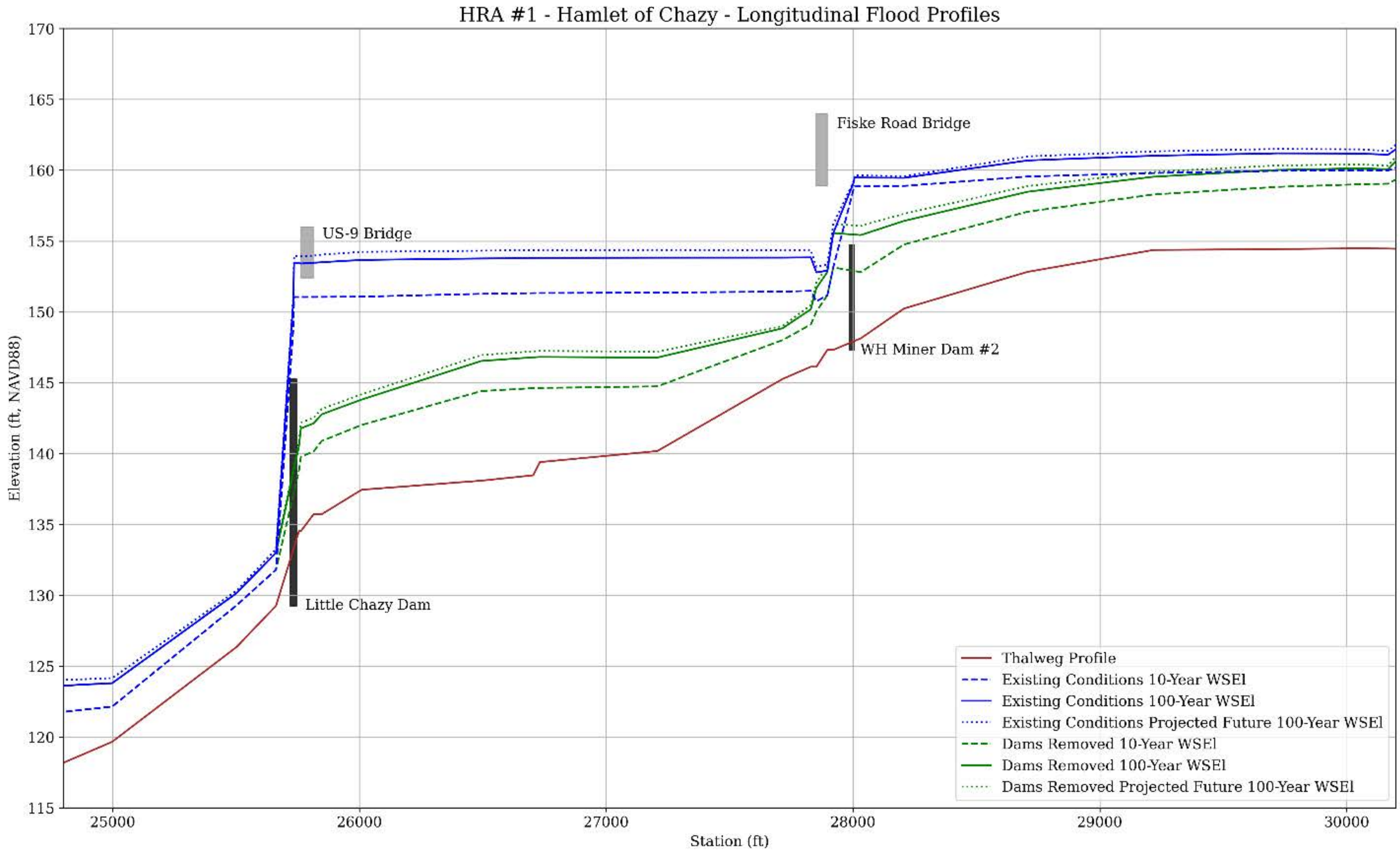

Figure 4-12: Flood profiles in the Hamlet of West Chazy; the 10-year and current and projected future 100-year flood elevations are shown under existing conditions and with the two dams removed.

The Fiske Road bridge crosses the Little Chazy River at STA 272+00 (NBI BIN: 1046260), shown in Figure 4-13. Hydraulic modeling shows that this concrete arch bridge generates minor backwaters. It has the capacity to convey flood flows without overtopping, including the current 500-year flood and projected future 100-year flood events. However, the river is significantly laterally constricted by this crossing, which contracts the approximately 80-foot-wide upstream channel into the 36-foot-wide hydraulic opening of the bridge. This can contribute to debris and ice jamming, which can significantly inhibit the bridge's performance, leading to excess flooding or potentially overtopping. Such a contraction can also generate adverse scour conditions. The bridge is relatively new, having been constructed in 1995; when it is due for replacement, a minimum 80-foot single span is recommended along with updated hydrologic and hydraulic analyses that account for projected future flows relevant to the new structure's anticipated lifetime. The new bridge should adhere to appropriate NYSDOT and NYSDEC stream crossing standards and guidelines.

Figure 4-13: Fiske Road concrete arch bridge, looking upstream from the left bank

Three low-head dams impound the Little Chazy River downstream of the Miner Dam, at STA 241+10, STA 244+50, and STA 247+50, which can be seen in Figure 4-2C. These structures are not included in the NYSDEC dam inventory (February 2021 Revision); inspection for inclusion in the database is recommended. The dams appear to be obsolete, and their removal is recommended as well.

A high-level conceptual relocation "Master Plan" of potential relocation areas for homes and businesses in HRA 1 is presented in Figure 4-14. The relocation master plan identifies potential areas where relocation generally seems to make sense for residential, retail/commercial, industrial, and other land uses identified through this assessment as having a potential to flood.

A total of 44 residential uses and 16 nonresidential and/or mixed-use properties (which include apartment buildings with an unknown number of units) were identified as potentially needing to be relocated. Of these 60 flood-prone properties, as many as 39 may be removed from the modeled 100-year floodplain with the proposed removal of the Little Chazy Dam and WH Miner Dam #2. Some of these properties are also prone to flooding in more frequent events; hydraulic modeled also indicates that dam removal may also remove 22 properties from the Little Chazy River's 10-year floodplain.

For potential relocation, sites were identified totaling 211 acres although not all that land was assumed to be developable due to natural features constraints that were eliminated from potential for development (primarily existing woodlands). Based on the analysis criteria utilized to calculate lot buildout, these parcels could provide relocation sites for all 44 residential uses, or more at a density generally consistent with the densities in the areas of each relocation site, utilizing existing cleared land area only. For the nonresidential uses, land was identified to provide a site for each use; however, many of these uses are commercial/retail uses that would likely want to remain in the heart of the hamlet, and there are an unidentified number of apartments on several properties that would need to be relocated. For the purposes of this exercise, it is assumed that any relocation would require generally the same acreage as exists today. The detailed breakdown for each site is as follows:

The number of properties identified as potentially needing to be relocated was based on a review of Clinton County, New York GIS data. In total, approximately 44 residential uses and 16 non-residential/mixed-use uses were identified as potentially needing to be relocated.

1) One parcel consisting of ~10 acres. Nonresidential/mixed-use development potential – likely higher density (~0.5 acre min. lot size per use). Access to Miner Farm Road (adjacent to I-87 northbound off ramp). Fifteen or more nonresidential lots/uses and/or mixed-use, depending on the density and site design, could likely be developed. The parcel is almost entirely cleared. The parcel is classified rural vacant > 10 acres.
2) One parcel consisting of ~6 acres. Residential development potential – likely higher density (~0.5 acre min. lot size). Access to Fiske Road and Brookside Lane. Four or more residential lots on the cleared portion of the site only, depending on density and site design, could likely be developed. The parcel is approximately 50 percent cleared. Significantly more could be developed if the site was cleared further. The parcel is classified rural vacant < 10 acres.
3) One parcel consisting of ~2 acres. Residential development potential – likely medium density (~1 acre min. lot size). Access to Washington Avenue. One or more residential lots, depending on density and site design, could likely be developed. The parcel is cleared. The parcel is classified as rural vacant < 10 acres.
4) One parcel consisting of ~9.5 acres. Nonresidential/mixed-use development potential – likely medium density (~1 acre min. lot size per use). Access to Miner Farm Road (adjacent to I-87 northbound on ramp). Two or more nonresidential lots/uses and/or mixed-use, depending on the density and site design, could likely be developed. The parcel is approximately 30 percent cleared. Significantly more could be developed if the site was cleared further. The parcel is classified as rural vacant < 10 acres.
5) One parcel consisting of approximately 0.75 acres. Nonresidential development potential – likely higher density (0.5 min. lot size). Access to Miner Farm Road. One nonresidential lot/use, depending on the density and site design, could likely be developed. The parcel is nearly fully cleared. The parcel is classified as vacant commercial.
6) One parcel consisting on ~169 acres. Residential development potential – likely medium density (~1 acre min. lot size). Access to Ratta Road. Forty-one or more residential lots, depending on density and site design, could likely be developed. The parcel is approximately 30 percent cleared. Significantly more could be developed if the site was cleared further. The parcel is classified as vacant with improvements.

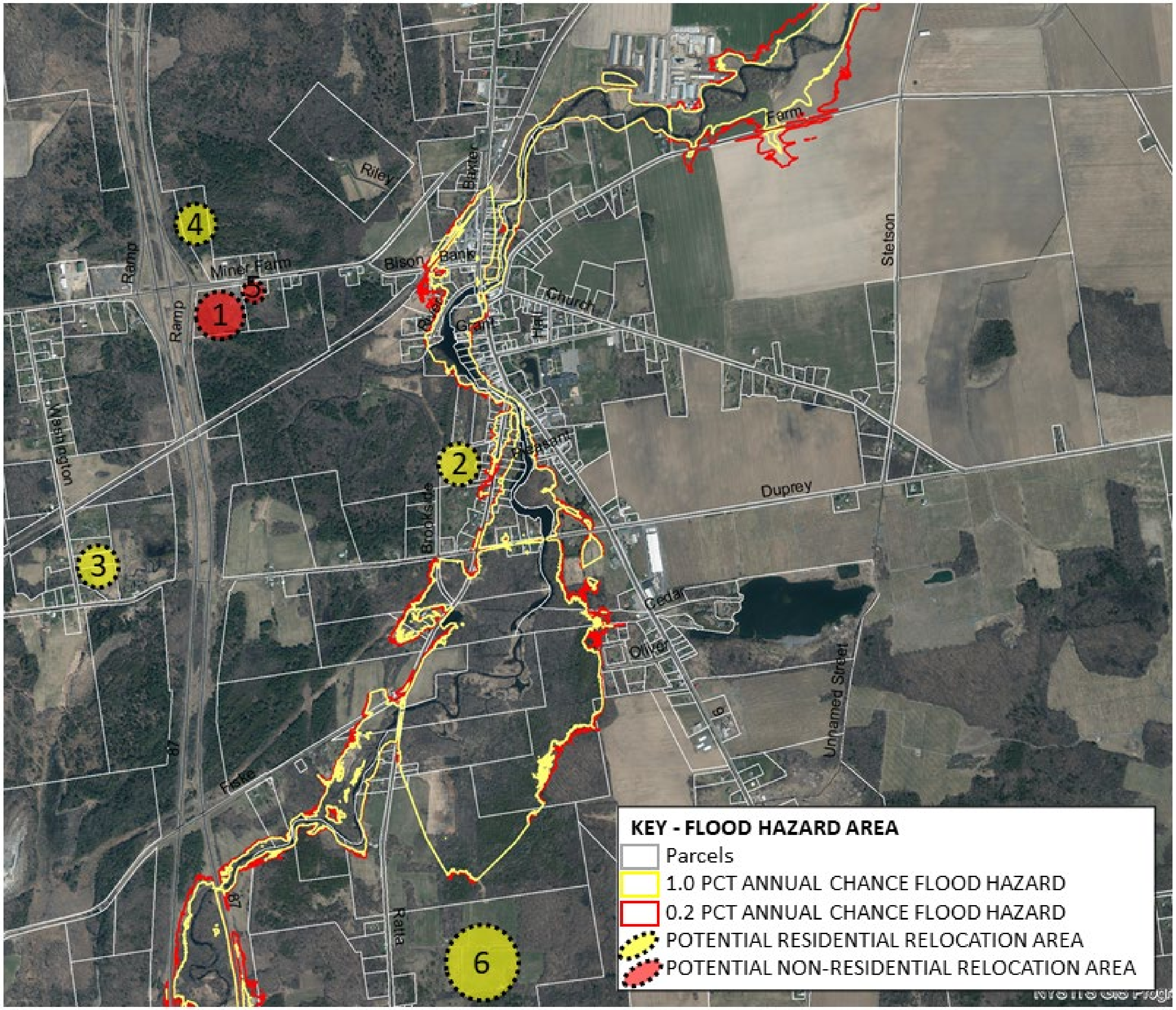

Figure 4-14: Conceptual Relocation Plan for HRA 1. See inset on previous page for details.

4.2 HIGH RISK AREA #2 – HAMLET OF WEST CHAZY AND TOWN OF ALTONA

HRA 2 includes the hamlet of West Chazy, beginning at STA 768+00, and extends upstream to the Flat Rock State Park in Altona at STA 1117+50, shown in Figures 4-15A and 4-15B. Assessed bridges include the Canadian Pacific railway crossing at STA 768+00, the NY-22 bridge at 779+50, and the county-owned West Church Street bridge at STA 768+50. Three dams along this reach were assessed as well. The hamlet of West Chazy is a small, primarily residential area located at the intersection of Route 22 and Fiske Road/West Church Street. The Little Chazy River cuts through the middle of the hamlet north of Fiske Road/West Church Street predominantly in a north-south orientation within a mostly wooded setting. Within HRA 2, there are many developed properties that are located both along the river and within the floodplain.

The following land use types are found within HRA 2: Tax Classification Codes 100 – Agricultural, 200 – Residential, 300 – Vacant Land, 400 – Commercial, and 600 – Community Services. Flood-prone areas include residences, apartments, and commercial uses. A New York State Electric and Gas (NYSEG) (public utility) facility is located within the floodplain, and a fire station and post office are located near to the modeled 500-year floodplain. The Clinton County Multi-Jurisdictional Hazard Mitigation Plan notes that there is a utility/power-generating station in the hamlet of West Chazy within the 500-year floodplain. There is also a wastewater treatment plant in the 500-year floodplain. Zoning and HMP information for the Town of Chazy as a whole are discussed in Section 4.1.

The Canadian Pacific railroad crossing of the Little Chazy River at STA 768+50 is severely undersized, with a span of just 16 feet and a rise of 10 feet above the streambed. Because of the railroad's elevated and relatively level embankment, minimal relief is available, and significant backwaters develop. Modeling indicates that more than 300 feet of railway is overtopped by more than 1 foot during the 10-year flood event and close to 2 feet in the 100-year flood event. Injected-grout pillows were observed along the toes of this bridge's abutments; the presence of these remediating scour countermeasures indicate a history of inadequate hydraulic performance and susceptibility to and prior instances of scour. Backwater flooding upstream of this bridge is not modeled as significantly affecting developed areas, but this undersized crossing may cause disruption of service or damage to railroad infrastructure during flood events. Replacement of the Canadian Pacific railroad bridge with a minimum 90-foot single span is recommended.

In the hamlet of West Chazy, a low-head dam is present at STA 780+00, immediately upstream of the NY-22 bridge crossing of the Little Chazy River ("West Chazy Dam;" NYSDEC: ID 217-0154; Federal ID: NY13635). According to NYSDEC's dam database, this concrete and masonry gravity dam is a Class A, High Hazard dam, built in 1901 and owned by a Stanley Farbotko. Its listed use is irrigation, although no such outlet works or diversions were observed; however, a dry hydrant, ostensibly for fire suppression, is present. It was last inspected in 1993, and its condition is currently not rated, although numerous seeps were observed during field investigations, one of which appeared to be significant along with structural cracking and evidence of alkali-silica reaction (ASR) within the concrete, shown in Figures 4-16, 4-17, and 4-18. The left upstream training wall was observed to be deteriorated as well and leaning toward the river; the left downstream abutment wingwall appears to be completely undermined (Figure 4-18).

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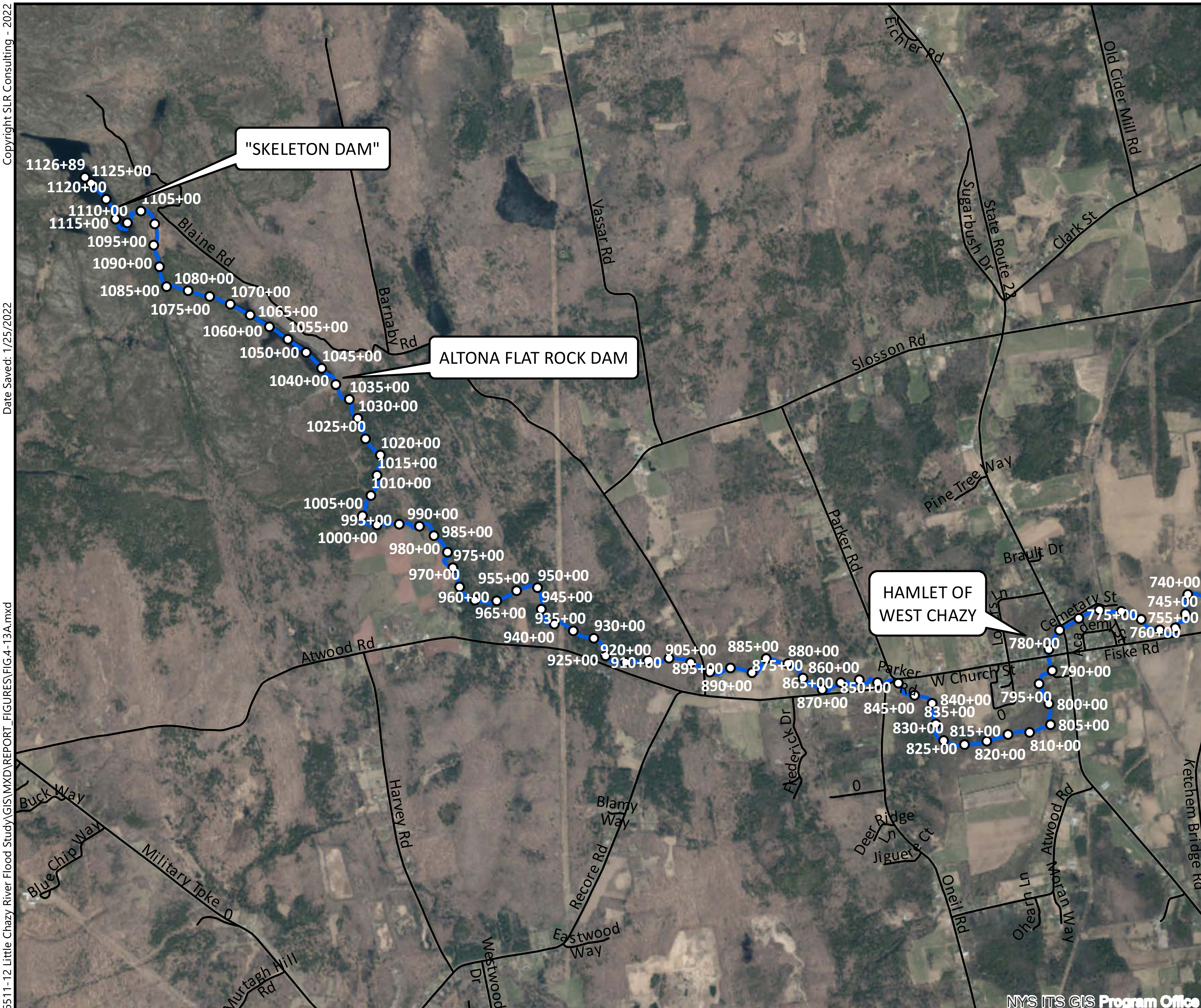

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Feet

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

HRA #2 - HAMLET OF WEST CHAZY

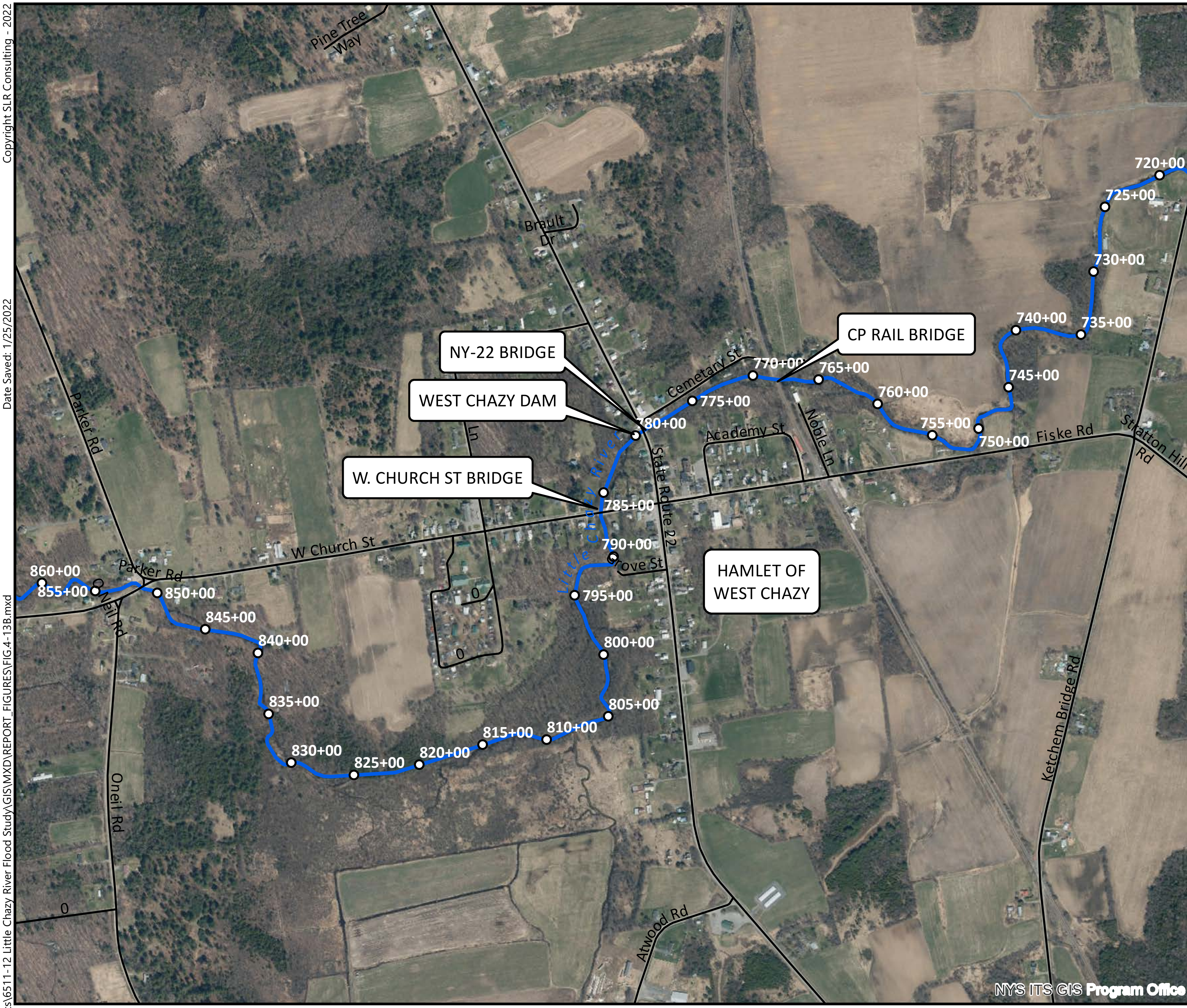
LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

SCALE 1 " = 3,000 '

DATE 1/25/2022

PROJ. NO. 16511.00012

FIG. 4-15A



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0 500 1,000
Feet

SLR
231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
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HRA #2 - HAMLET OF WEST CHAZY
LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

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DATE 1/25/2022

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FIG. 4-15B

Date Saved: 1/25/2022

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The West Chazy Dam structure's listed spillway height is 12 feet, although bedrock ledge was observed immediately upstream and downstream of the dam, indicating a natural falls at this location; the dam appears to raise the natural normal upstream water surface by just a few feet. Modeling indicates that this dam's backwater affects two upstream properties in both the 10-year and 100-year flood events, which would be alleviated by removing the dam. Hydraulic modeling also demonstrates that the right training wall and top of dam are overtopped in the 25-year flood event, indicating inadequate spillway performance and potential exposure to loadings in excess of design, both of which can increase the risk of dam failure. Removal of the dam and restoration of the natural falls is recommended. A more conventional dry hydrant system, which does not require impoundment of the river, is recommended to replace the current fire suppression appurtenances. A typical detail is shown in Figure 4-32.

Figure 4-16: West Chazy Dam. Note significant seep at center-bottom of main dam section, evidence of ASR in the concrete, crack and deteriorated concrete, and vegetation growing in the concrete spillway.

Figure 4-17: West Chazy Dam. Note major seep, ASR, cracks, and deteriorated concrete.

Figure 4-18: West Chazy Dam. Dry hydrant is visible near the center of the image, and the left abutment of NY-22 bridge is visible at right. Note deteriorated spillway crest and deteriorated left upstream training wall is leaning toward the river. The dam's left downstream abutment wingwall appears to be completely undermined (visible just to the right of vertical section of dry hydrant).

The NY-22 bridge at STA 779+50, just downstream of the West Chazy Dam, consists of an older stone masonry arch bridge, with a newer, wider, concrete superstructure and deck set on top of the old structure (NBI BIN: Not Listed). Hydraulic modeling shows that the bridge passes the current 100-year flood event but is expected to overtop in the projected future 100-year flood. The structure represents an extreme lateral constriction, contracting the 60-foot-wide channel into a roughly 19-foot-wide bridge opening, as shown in Figures 4-19 and 4-20. Generally, such a flow contraction can generate adverse scour conditions; however, this bridge is founded on bedrock, which reduces this hazard somewhat. The bridge's short span is also prone to debris jamming. When it is due for replacement or significant upgrade or repair, a minimum 60-foot replacement single-span bridge is recommended, to be verified with updated detailed hydrologic and hydraulic analyses that account for projected future flows relevant to the new structure's anticipated lifespan. The new bridge should adhere to appropriate NYSDOT and NYSDEC stream crossing standards and guidelines. The current bridge does not appear in the 2020 National Bridge Inventory (NBI), presumably because its less-than-20-foot span does not meet the NYSDOT definition of a bridge. Replacement of this bridge in itself is not expected to significantly reduce the clear water flooding hazard in its proximity unless accompanied by removal of the West Chazy Dam, which is largely a consequence of the hydraulic interdependence between the two structures.

Figure 4-19: NY-22 bridge immediately downstream of the West Chazy Dam. Note significant contraction into bridge and dry hydrant in foreground as well as deteriorated spillway concrete.

Figure 4-20: NY-22 bridge, looking downstream. Note the additional contraction into the older masonry arch within the bridge; deterioration of concrete knee walls, and spalling, ASR, and exposed rebar in the new concrete superstructure.

West Church Street crosses the Little Chazy River at STA 786+50 with a concrete and stone masonry arch bridge that was constructed in 1909, shown in Figure 4-21 (NBI BIN: 3336190). The bridge is undersized, generating over 6 feet of additional backwater in the 100-year flood event, contributing to excess flooding as far as 900 feet upstream of the bridge, which affects 12 homes. The projected future 100-year flood event is expected to overtop the bridge deck and roadway by as much as 1.6 feet. The channel upstream and downstream is entrenched and confined by dry-laid masonry walls on both banks, shown in Figure 4-22. Injected-grout pillows were observed along the toes of this bridge's abutments; the presence of these remediating scour countermeasures indicate a history of inadequate hydraulic performance and susceptibility to and prior instances of scour. It is recommended that this bridge be replaced with a minimum 90-foot single-span bridge, to be accompanied by channel restoration and floodplain enhancements upstream and downstream of the bridge to alleviate the current entrenched condition. Modeled floodplain reconnection included regrading of about 300 feet of the vertically walled right bank to a more natural bank slope of 2H:1V, and excavation of between 1 foot and 4 feet along a roughly 400-foot long, 25-foot-wide strip of connected floodplain along the left bank. Properties upstream and downstream of the bridge are affected by these modifications, although the proposed disturbance is essentially limited to the immediate overbank areas, and no structures are impacted. This is necessary to allow the proposed bridge to achieve sufficient hydraulic performance to generate the flood mitigation benefits described above.

With the proposed modifications for HRA 2, shown conceptually in Figure 4-23, eight homes and businesses may be removed from the 100-year floodplain and an additional three homes from the projected future 100-year floodplain. Due to the Little Chazy River's flat slope upstream of the West Church Street bridge, which can be seen in longitudinal profile in Figure 4-24, only minor flood mitigation benefits are possible beyond those seen with the dam and existing bridge constrictions removed. Flood mapping showing the depth and extent of flooding in the 10-year and 100-year current and future flood events, under existing and proposed conditions, is presented in Figures 4-25 through 4-28.

Figure 4-21: West Church Street bridge, looking downstream across the road surface

Figure 4-22: Confined and entrenched channel immediately upstream of the West Church Street bridge

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HRA #2 - HAMLET OF WEST CHAZY CONCEPT LAYOUT

LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

SCALE 1 " = 500 '

DATE 2/2/2022

PROJ. NO. 16511.00012

FIG. 4-23

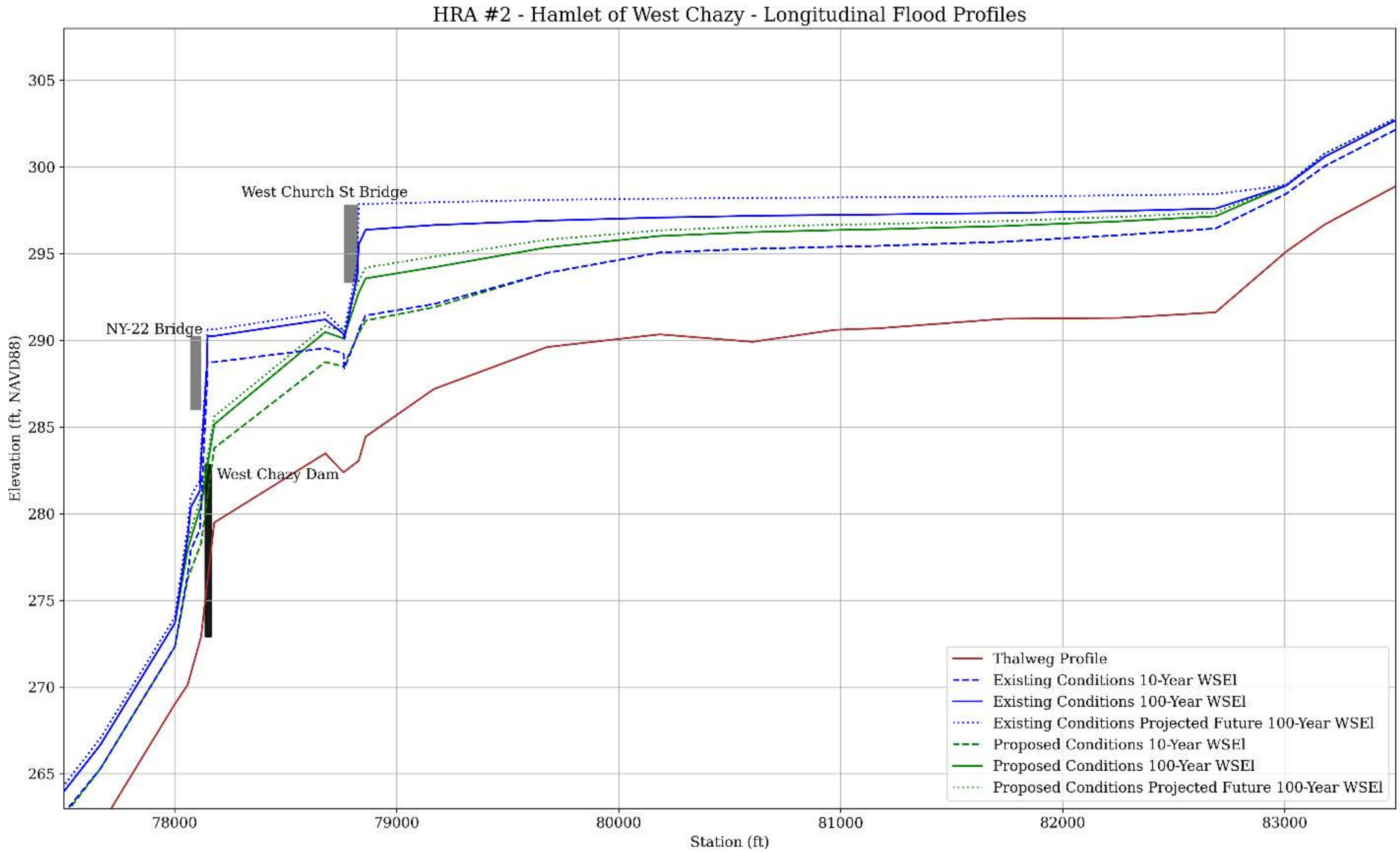
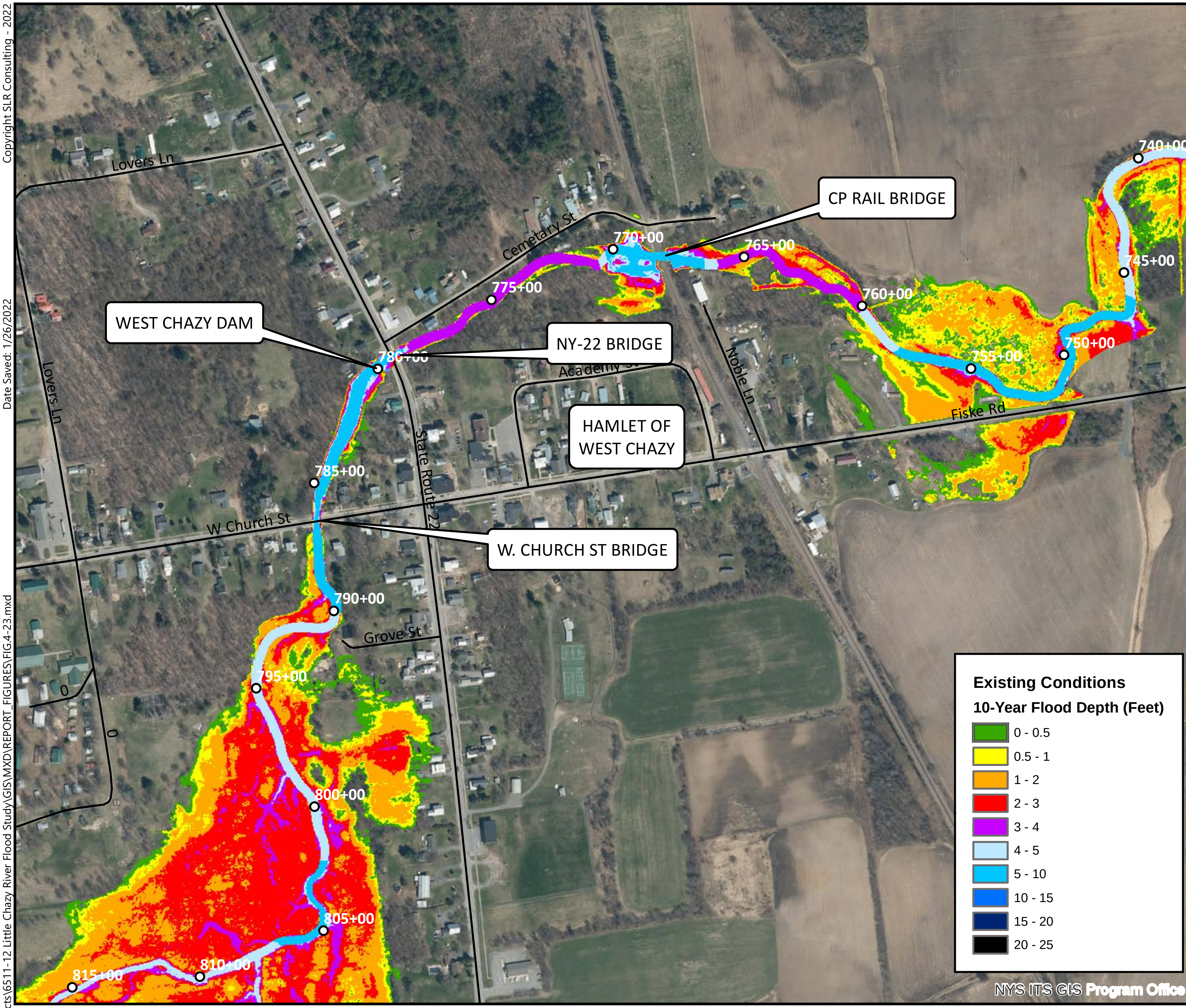


Figure 4-24: Longitudinal flood profiles in HRA 2 showing the current 10-year flood event and current and projected future 100-year floods under existing conditions and proposed conditions, which include replacement of both the NY-22 and W. Church Street bridges, and removal of the West Chazy Dam. Flood mitigation benefits are at their greatest in the vicinity of the dam and bridges, diminishing upstream due to the river's naturally flat slope.



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HRA #2 - EXISTING CONDITIONS - 10-YEAR FLOOD

LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

SCALE 1 " = 500 '

DATE 1/26/2022

PROJ. NO. 16511.00012

FIG. 4-25

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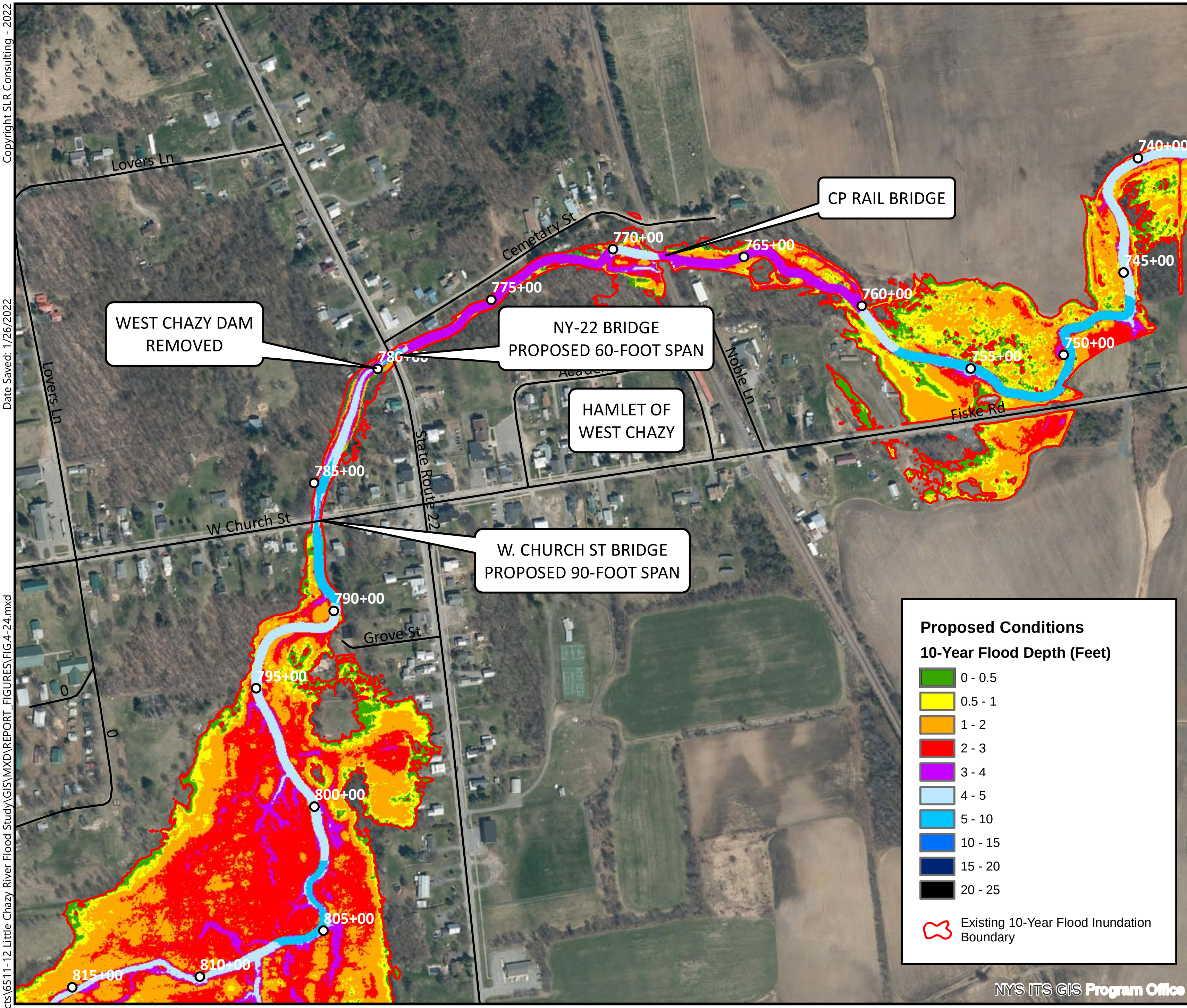

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HRA #2 - PROPOSED CONDITIONS - 10-YEAR FLOOD

LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY

SD122

CLINTON COUNTY
NEW YORK

SCALE 1 " = 500 '

DATE 1/26/2022

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FIG. 4-26

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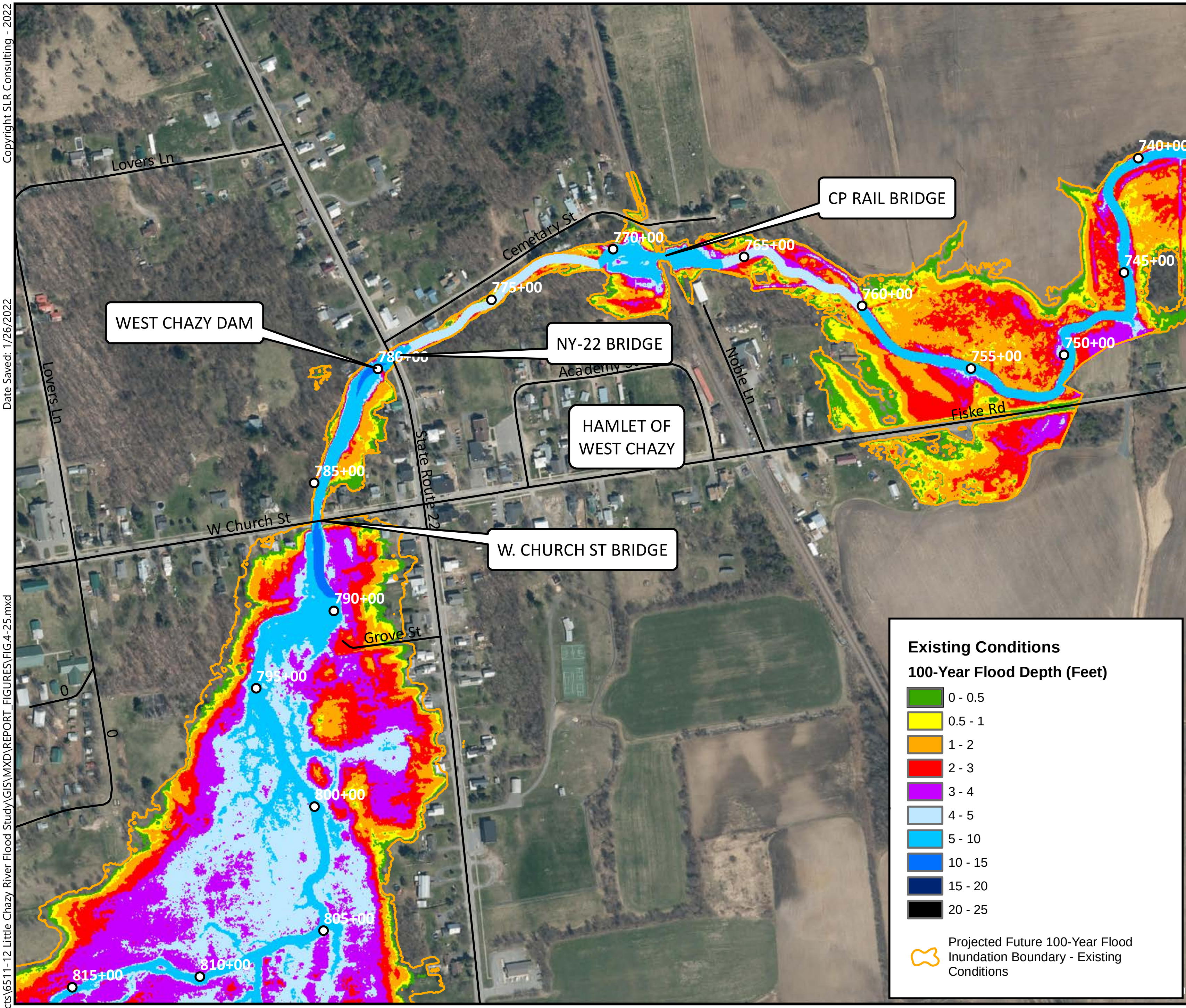

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HRA #2 - EXISTING CONDITIONS - 100-YEAR FLOOD

LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY

SD122

CLINTON COUNTY

NEW YORK

SCALE 1 " = 500 '

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FIG. 4-27

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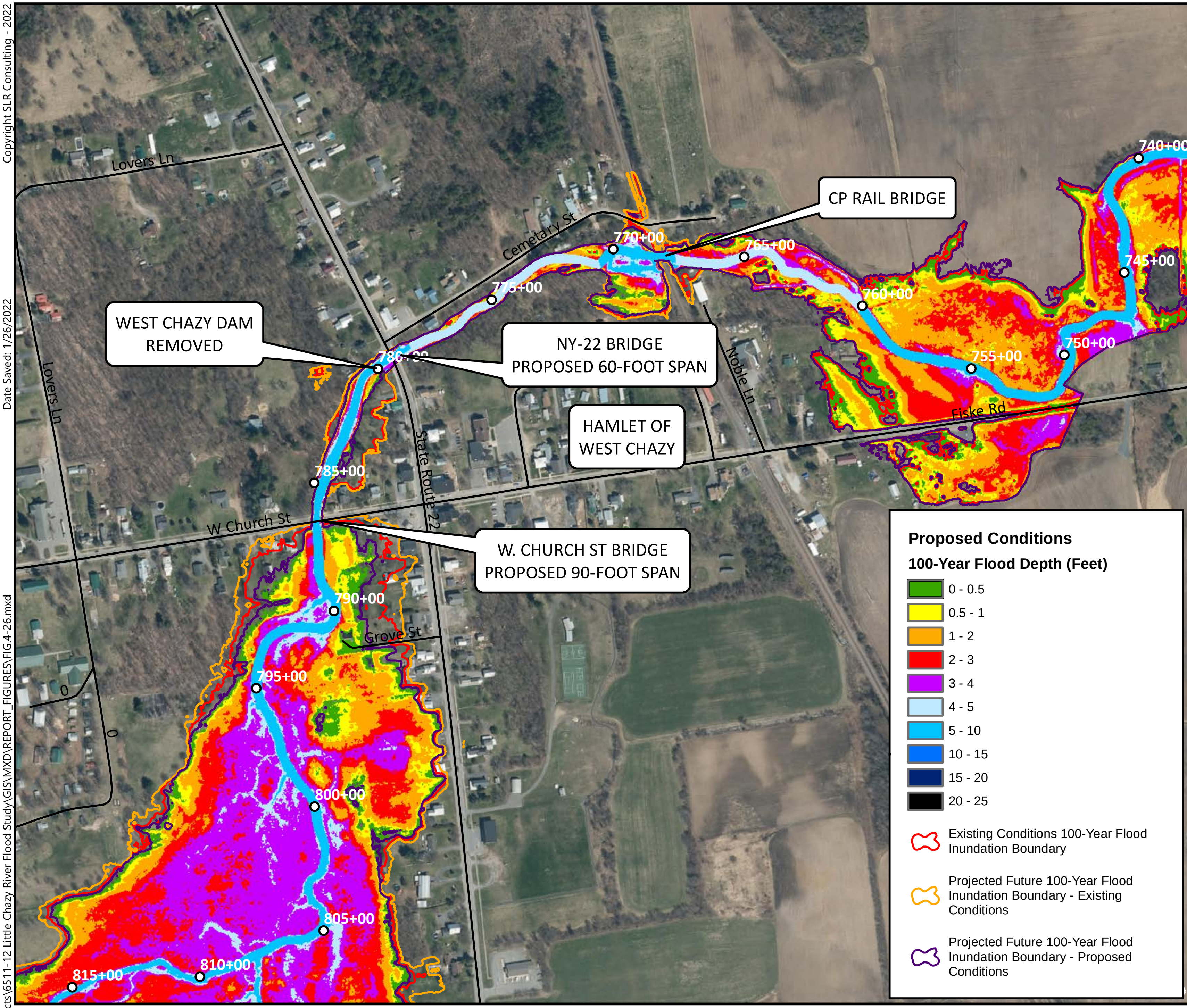

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HRA #2 - PROPOSED CONDITIONS - 100-YEAR FLOOD

LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

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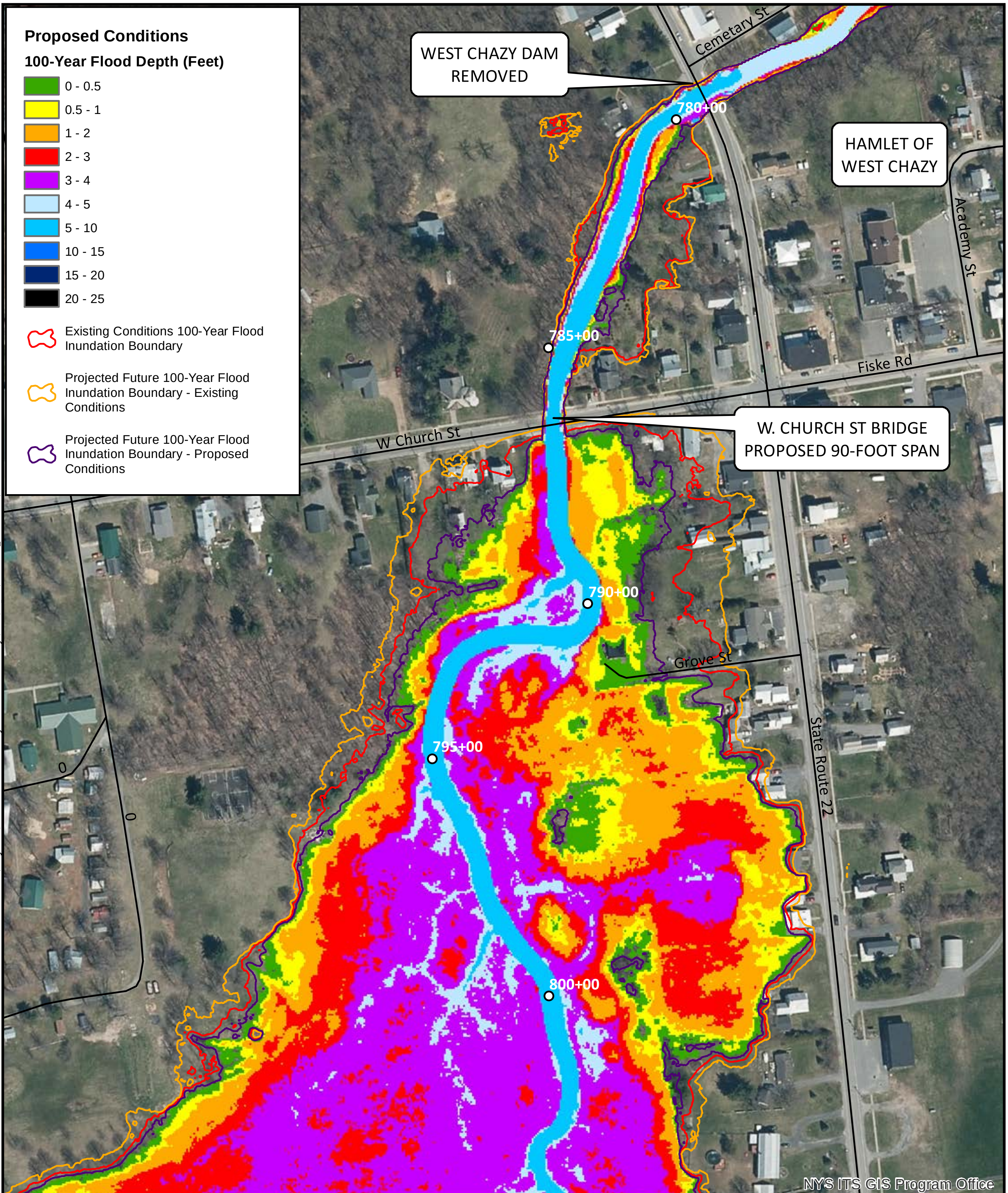
FIG. 4-28



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HRA #2 - PROPOSED CONDITIONS - 100-YEAR FLOOD

LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

SCALE 1 " = 250 '

DATE 4/7/2022

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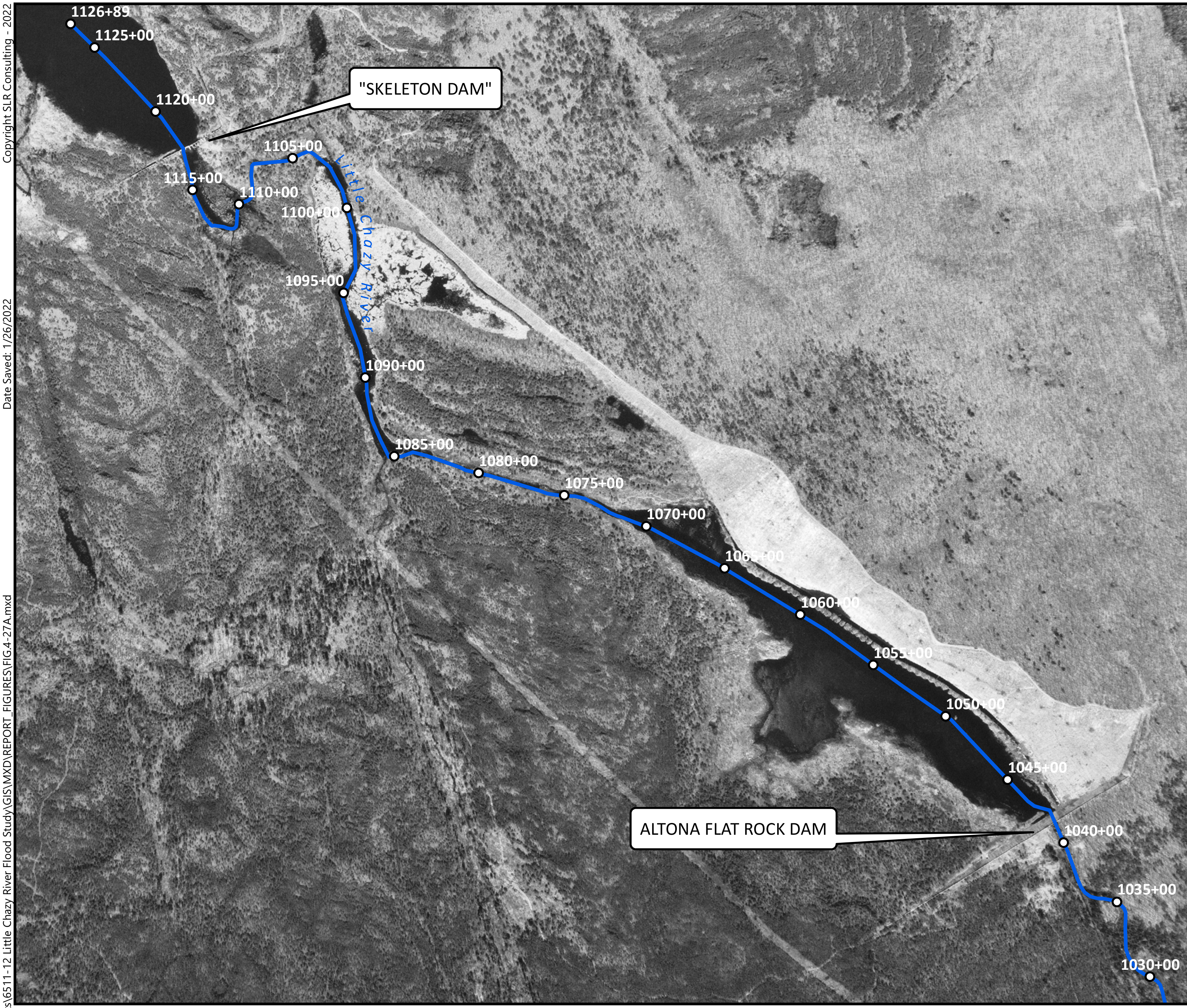
FIG. 4-28B

Upstream of West Chazy, two nonoperational dams are present in the Altona Flat Rock State Forest. The first, at STA 1041+00, an Ambursen-style flat slab and buttress dam built by W.H. Miner, and originally designed to hold 1.5 billion gallons (4,600 acre-feet) of water for hydroelectric power (NYSDEC: ID 217-0165; Federal ID: NY13636). Construction began in 1911, but after filling the impoundment initially in 1917, the dam was plagued by seepage and mechanical issues, and the project was abandoned after just 7 years. The majority of the impoundment's left bank was reportedly covered in concrete in an effort to inhibit this seepage, to no avail. This is visible in historical and modern aerial imagery shown in Figures 4-29A (1964 aerial) and 4-29B (2020 aerial). The NYSDEC dam inventory refers to this 2,300-foot-long, 30-foot-high dam as "Miner Dam" but is alternatively known as the Altona Dam or Flat Rock Dam; colloquially the boondoggle is known as the "Million Dollar Dam." Hereafter in this report, it is referred to as the Altona Flat Rock Dam to avoid confusion with the Miner Dam at STA 131+30. The NYSDEC dam inventory lists the owner of the Altona Flat Rock Dam as William H. Miner, who passed away in 1930, although the property is currently operated by the William H. Miner Agricultural Research Institute.

Flows currently pass through the dam via a small breach in one of the concrete slabs adjacent to the original outlet works. Based on 0.5-foot resolution aerial orthoimagery collected in 2020, the breach is estimated to be approximately 15 to 18 feet wide and is therefore likely to be prone to debris and possibly ice jamming; excess ice formation in the dam's dead pool is also possible. Jamming or clogging may cause the impoundment to fill if coincident with a discharge that exceeds the rate of seepage into the adjacent ground; both conditions may be expected in a flood event. Blockage of the breach may also result from or be exacerbated by beaver activity. The area surrounding this dam is operated by the William H. Miner Agricultural Research Institute, but this dam has been abandoned for a century, and it may no longer be capable of bearing the forces generated by even a partially filled reservoir. This is discussed further in Section 4.3.

This dam is currently rated as a Class D Negligible or No Hazard Dam. This categorization may underestimate the dam's hazard, given that the majority of this very large dam is in place and the potential exists for some portion of the considerable impoundment to fill during flood conditions or due to blockage of the current small breach. The consequences of dam failure could affect downstream property and infrastructure and present a life safety hazard. Reconsideration of this dam's current hazard classification is recommended based on an assessment that includes dam break scenarios that consider partially full and full impoundment levels. Removal of this dam is recommended; because it is more than half a mile long, complete removal may not be feasible, in which case removal of approximately 300 feet of the structure, roughly centered at the dam's outlet, would allow unrestricted passage of modeled flood flows.



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HRA #2 - ALTONA FLAT ROCK & "SKELETON" DAMS - 1964 AERIAL

LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY

SD122

CLINTON COUNTY
NEW YORK

SCALE 1 " = 750 '

DATE 1/26/2022

PROJ. NO. 16511.00012

FIG. 4-29A

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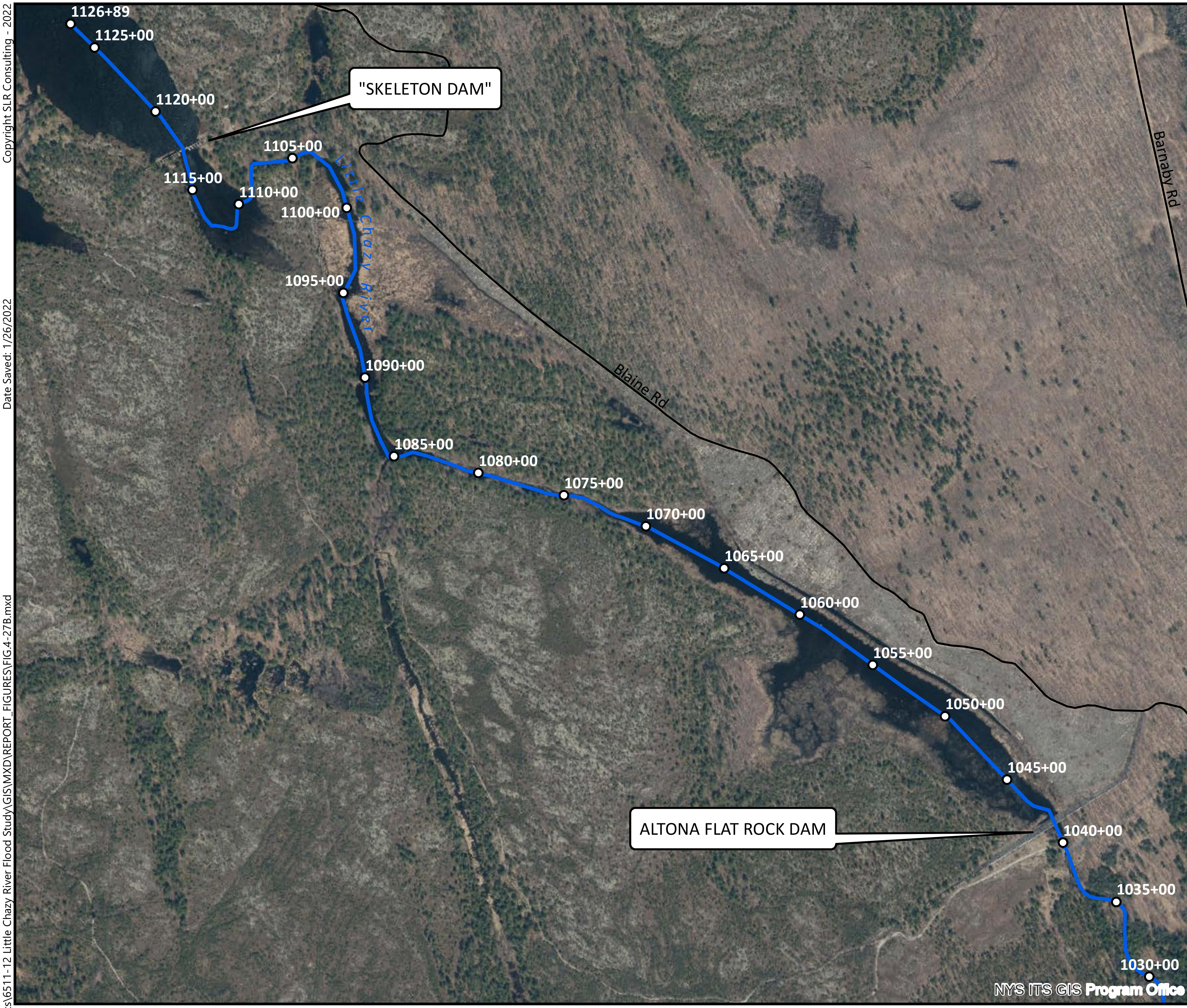

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HRA #2 - ALTONA FLAT ROCK & "SKELETON" DAMS - 2020 AERIAL
LITTLE CHAZY RIVER FLOOD & ICE JAM STUDY
SD122
CLINTON COUNTY
NEW YORK

SCALE 1 " = 750 '
DATE 1/26/2022
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FIG. 4-29B

Just upstream of the intended impoundment of the Altona Flat Rock Dam, another of W.H. Miner's concrete slab-and-buttress dams is present at STA 1117+50. This 700-foot-long dam is not in the NYSDEC's current dam inventory (February 2021 Revision) but is colloquially known as the "Skeleton Dam" due to its appearance as many of the buttresses were completed, but the project was abandoned before all of the slabs were constructed. It can be seen in Figures 4-29A (1964 aerial) and 4-29B (2020 aerial). The incomplete structure obstructs flow and is an impediment to ice and debris passage, potentially leading to blockage of the river and filling of some portion of the impoundment. This may also result from or be exacerbated by beaver activity. Because it was never completed and has been abandoned for a century, the structure is presumed to be unsound and unlikely to withstand significant loadings, presenting a safety hazard. Inspection by NYSDEC for inclusion in the dam database is recommended. Removal of this dam is recommended.

A high-level conceptual relocation "Master Plan" of potential relocation areas for homes and businesses in HRA 2 is presented in Figure 4-30. The relocation master plan identifies potential areas where relocation generally seems to make sense for residential, retail/commercial, industrial, and other land uses identified through this assessment as having a potential to flood.

A total of 46 residential properties and five nonresidential or mixed-use properties were identified as potentially needing to be relocated. Under proposed conditions, as many as 10 of these properties may be removed from the current 100-year floodplain and 14 properties from the projected future 100-year floodplain.

For potential relocation, sites were identified totaling approximately 60 acres. Based on the analysis criteria utilized to calculate lot buildout, these parcels could provide relocation sites for all 46 residential uses, or more at a density generally consistent with the densities in the areas of each relocation site, utilizing existing cleared land area only. For the nonresidential uses, only one likely viable nondeveloped, nonagricultural location was identified. It is classified as vacant, although it has a structure on it, and it is in the heart of the hamlet. We would assume that many of these uses are commercial/retail uses that would likely want to remain in the heart of the hamlet and along one of the major roads. There are no other viable locations not on agricultural land unless they are sited well outside the hamlet. For the purposes of this exercise, it is assumed that the cemetery and NYSEG utility property likely would not be relocated, so the exercise comes up short two potential nonresidential relocation parcels. It is assumed that any relocation would require generally the same acreage as exists today, for the purposes of this exercise. The detailed breakdown for each site is as follows:

The number of properties identified as potentially needing to be relocated was based on a review of Clinton County, NY GIS data. In total, approximately 46 residential uses and five nonresidential/mixed-use uses were identified as potentially needing to be relocated.

1) One parcel consisting of ~ 0.75 acres. Nonresidential potential. Access to Fiske Road. One nonresidential lot/use is possible, depending on the density and site design. The parcel has an existing structure that would need to be removed. The parcel is classified vacant with improvements.
2) One parcel consisting of ~ 0.30 acres. Residential potential – likely higher density (~0.5 ac. min. lot size). Access to Fiske Road. One single-family residence or one apartment building with several apartments, depending on the density, site design, and parking requirements, could likely be developed. The parcel is cleared. The parcel is classified vacant with improvements.
3) One parcel consisting of ~5.5 acres. Residential potential – likely medium density (~1 ac. min lot size). Access to Route 22. The parcel is a flag lot that could provide for three or more lots, depending on the density and site design. The parcel is approximately 50 percent cleared, additional clearing of existing trees could provide more developable land. The parcel is classified rural vacant < 10 ac.
4) One parcel consisting of ~ 1 acre. Residential potential – likely medium density (~1 ac. min. lot size). Access to Atwood Road. One lot possible. The parcel is entirely cleared. The parcel is classified as rural vacant < 10 ac.
5) One parcel consisting of ~7.5 acres. Residential potential – likely medium density (~1 ac. min. lot size). Access to Atwood Road. Five residential lots possible, depending on the density and site design. The parcel is entirely cleared. The parcel is classified abandoned ag.
6) One parcel consisting of ~2.2 acres. Residential potential – likely medium density (~1 ac. min. lot size). Access to West Church Street. The parcel is a flag lot that could potentially provide for two residential lots, depending on the density, site design, and parking requirements. The parcel is entirely cleared. The parcel is classified rural vac <10 ac.
7) One parcel consisting of ~43 acres. Residential potential – likely medium density (~1 ac. min. lot size). Access to O'Neil Road. Thirty-two lots possible, depending on the density and site design. The parcel is entirely wooded and would need at least selective tree removal to be viable. The site is one of only a few nondeveloped and nonagriculture sites within close proximity to the developed hamlet area that has development potential, which is why it was considered despite being woodlands. The parcel is classified as vacant with improvements.

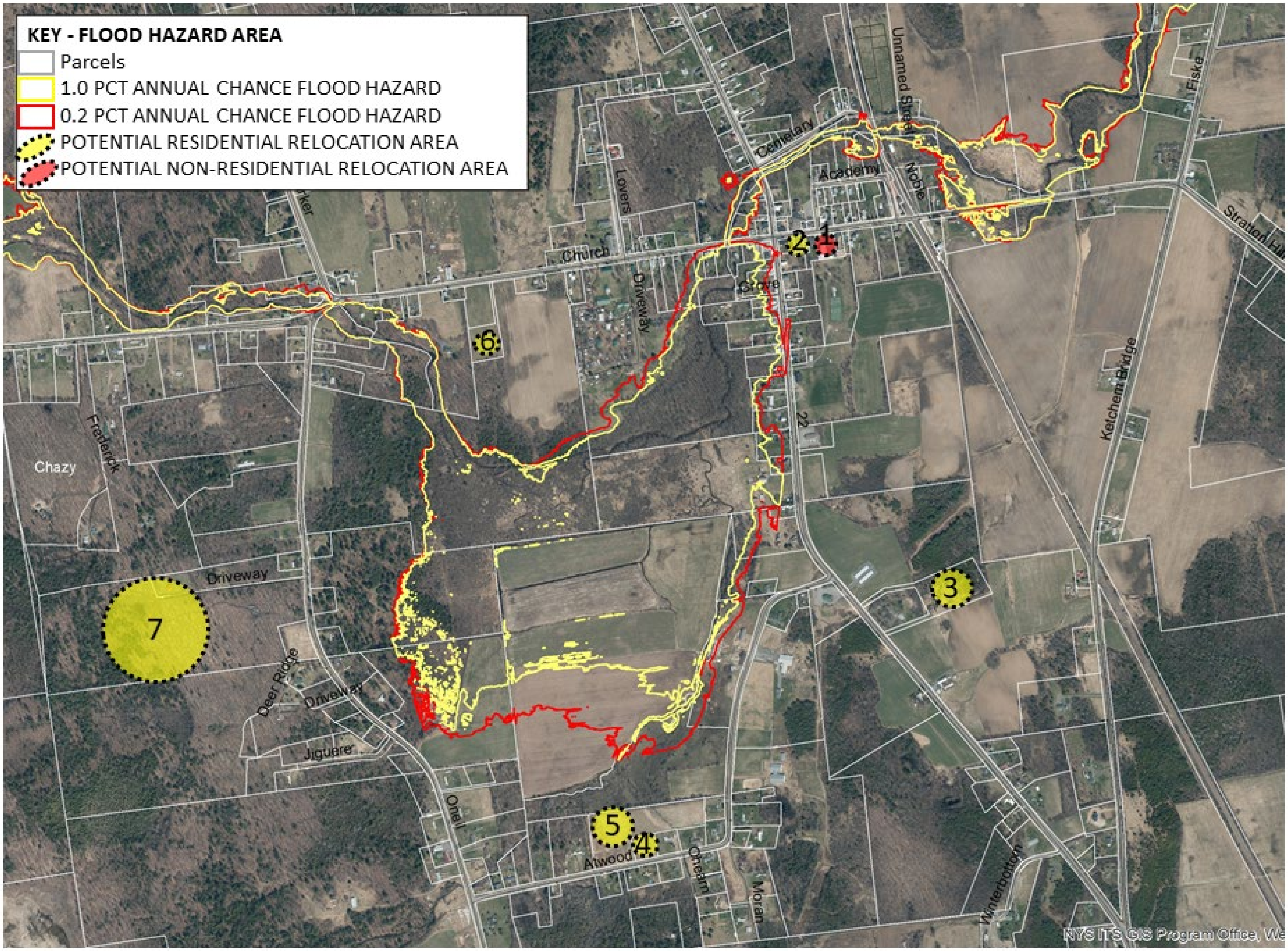


Figure 4-30: Conceptual Relocation Map for HRA 2. See inset on previous page for details.

4.3 DAMS IN THE LITTLE CHAZY WATERSHED

Many dams impound the Little Chazy River and its tributaries. While several of these dams are evaluated and discussed in the preceding HRA discussions, many more are located beyond the limits of the specific HRAs. This section includes a discussion and general recommendations that apply to dams throughout the watershed.

Most of these are obsolete relative to their original purposes, although some are currently used to supply pump water for fire suppression in local communities, and the farthest-downstream dam on the river currently acts as a barrier to sea lamprey migration from Lake Champlain. Some dams are constructed on natural bedrock features and are relatively small in height as sufficient head differential was provided by the natural falls and only a small structure was required to divert flows to a penstock or headrace. These generally impound small volumes of water, generate minor backwaters, and as a result often pose lower hazards to downstream areas, so flood mitigation benefits of dam removal can be limited, although the recreational and aesthetic benefits of restoring a natural waterfall are not inconsequential. Other, taller dams with larger impoundments can exacerbate upstream flooding damages, contribute to ice formation, and pose a greater hazard to property, infrastructure, and life safety in downstream areas. In some cases, these dams are abandoned or are in poor condition. Removal of such dams should be prioritized.

Many of the larger dams constructed in the Little Chazy watershed from the 1900s through the 1920s are structural dams built in the Ambursen flat slab and buttress style. As these dams reach or exceed their functional lifespan, the age and the condition of the reinforced concrete used in their construction is important to consider since unlike massive dams this type of structural dam makes use of reinforced concrete to bear the load of the impoundment rather than relying on the weight of the structure. Deterioration is inevitable, and these dams have been in service well beyond the typical design life of even modern reinforced concrete. Despite rapid and major advancements in reinforced concrete construction in the late 19th and early 20th centuries, the state of the art was essentially in its infancy when many of these dams were built, and Ambursen dams were themselves a new technology, the first having been built in just 1903 (USBR 2005).

A critical aspect of this construction style is that overturning forces are primarily resisted by concrete buttresses on the downstream side of the dam rather than by the weight of the structure as with a gravity dam. They are also generally not heavy enough to resist sliding forces by their weight alone, so stability is provided by the vertical force of the water column on the inclined upstream face. Both overturning and sliding resistance are aided by the fact that hydrostatic uplift forces are considerably diminished due to the dams' small footprints compared to a massive dam. These factors made them relatively inexpensive to build, with the spaced buttresses and thin slabs providing significant time and material savings over a monolithic gravity dam, but the reliability of the structure hinges entirely on the integrity of the reinforced concrete in each individual element. Just like links in a chain, failure of a single slab or buttress is generally catastrophic.

When these dams were built, reinforced concrete was still commonly considered to be a "maintenance-free" construction material that would last for hundreds of years (Clark, 2000), and several of these dams were only operated for a few decades or less before abandonment. It is therefore conceivable that some of these dams may have never undergone any significant maintenance in the century or more since they were completed. While unreinforced concrete can last for centuries, the reality is that deterioration of reinforced concrete begins within 10 to 20 years or earlier, depending on construction techniques and environmental conditions (Moriconi, 2009). Concrete is permeable and prone to cracking, and any embedded structural steel has almost certainly experienced corrosion, which can be accelerated by chemical interactions within the cement (e.g., alkali-silica reaction, which causes expansion), increasing exposure to moisture over time due to cracking and spalling. Steel also expands as it corrodes, leading to further exfoliation and growth of cracks.

Many dams in the Little Chazy River watershed were also built before rigorous statistical analyses were first applied to flood hydrology in the 1940s (Gumbel, 1941) and, as such, are prone to hydraulically undersized spillways, which can cause overtopping of sections of dam that were not designed for this purpose such as earthen closure embankments or training walls with unprotected downstream footings. This can lead to undermining and erosion, as was seen in the neighboring Great Chazy River watershed at the McGregor Dam, which impounds the North Branch Great Chazy River just upstream of the Canaan Road bridge in Ellenburg Depot in August 2010 (note: this 10-foot tall dam has the same name as the larger McGregor Dam that impounds the main stem of the Great Chazy River to create Miner Lake; both are discussed in the Great Chazy River Flood Mitigation and Resilience Report SD119 [SLR 2022]). Overtopping damages included erosion of the left earthen closure embankment and undermining of the dam's left abutment, pictured in Figures 4-31 and 4-32. Further, when overtopped, these dams can be exposed to greater loads than were anticipated in their design, which can damage the structure anywhere from imperceptibly to catastrophically. As time goes on and unavoidable deterioration progresses, the ability to resist loadings in excess of design, and even design conditions, will diminish. When subjected to major flood events such as Tropical Storm Irene in 2011 or projected future flood scenarios, preexisting structural deficiencies increase the risk of failure. Dam failure can have devastating consequences, including injury, loss of life, and damage to property and infrastructure.

Figure 4-31: Overtopping during flooding in August 2010 caused washout of left embankment and undermining of abutment of McGregor Dam near the Canaan Road bridge in Ellenburg Depot. Photo provided by Clinton County Emergency Services.

Figure 4-32: Damage to McGregor Dam on North Branch Great Chazy River due to overtopping in August 2010. Canaan Road bridge in background. Photo provided by Clinton County Emergency Services.

The images in Figures 4-33 and 4-34 depict the LaSell Dam on the Great Chazy River after completion in the 1920s and in 2007 after nearly 50 years of abandonment, respectively. This dam is discussed in the Great Chazy River Flood Mitigation and Resilience Report (SLR, 2022). Note the severe deterioration of the structural concrete and that one of the slabs in the dam's primary spillway section had failed, although the impoundment would still fill and spill over the dam during high flows. This dam was removed following further damage sustained during Tropical Storm Irene in 2011.

While there are many unknowns regarding the exact construction techniques used in specific dams, these are fundamental characteristics of many of these dams' type and age that may be responsible for structural and/or hydraulic deficiencies today. While decades of neglect and lack of maintenance can exacerbate these issues considerably, even with regular upkeep, these structures have surpassed their service life and may pose a safety hazard. For long-abandoned dams, the necessary repairs may be so extensive as to be considered reconstruction, thus requiring adherence to modern dam safety requirements for new dams, including stability, spillway hydraulic performance, and impoundment evacuation. For many such deteriorating dams, the cost of rehabilitation or replacement is generally prohibitive, especially since there is no longer an active use for most of these dams. Deferment is not appropriate given the emergent safety hazards of a structurally or hydraulically deficient dam. Often, the only feasible alternative is dam removal. If these dams continue to decay without intervention, they will eventually collapse into the streams and rivers they impound, the consequences of which could be severe, especially if coincident with flooding. Removal of abandoned nonoperational dams to eliminate the hazards they present is recommended as general practice.

Figure 4-33: LaSell Dam on the Great Chazy River in the 1920s. McGregor Powerhouse in background.

Figure 4-34: LaSell Dam on the Great Chazy River in 2007. The hydroelectric project was abandoned in the late 1950s – early 1960s and the penstocks and turbines sold for scrap. Note severe deterioration and evidence of alkali-silica reaction in the structural concrete and that one of the slabs in the primary spillway section had failed.

Four dams on the Little Chazy River were identified that are not included in NYSDEC's current dam inventory (February 2021 Revision):

- A series of three low-head dams in the hamlet of Chazy at STA 241+10, STA 244+50, and STA 247+50
- A partially completed 700-foot-long concrete slab and buttress dam in Altona at STA 1117+50

It is recommended that these dams be inspected for inclusion in the database. These structures are also recommended for removal.

The level of effort and cost of design and implementation of each dam removal will vary depending on various factors such as the quality and quantity of impounded sediment, need for grade control or scour protection measures at upstream crossings, construction accessibility, and other site-specific considerations. As an interim step prior to dam removal, it is recommended that a dam removal feasibility study be undertaken at each site to further refine the cost and level of effort required for removal.

The listed owner of the Miner Dam at STA 131+30, the Fordams Mills Dam presumed to be located at STA 198+00, and the Altona Flat Rock Dam at STA 1041+00, according to the February 2021 revision of the NYSDEC dam inventory, is the late William H. Miner (1862-1930). Per 6 NYCRR Part 673, transferal of dam ownership requires transmission of pertinent records as well as notice to NYSDEC Dam Safety Section and documentation of transfer of dam ownership no later than the date of transfer. It is recommended that

NYSDEC ascertain the current owners of these dams and, with all dams in the watershed as appropriate, take necessary action to enforce the responsibilities of dam ownership set forth in 6 NYCRR Part 673 and Environmental Conservation Law (ECL) § 15-0507. Owners of “Unsafe,” “Unsound,” or otherwise deficient dams are in violation of 6 NYCRR Part 673 and ECL § 15-0507.

Many dams in the Little Chazy River watershed were last inspected in the 1970s, according to the NYSDEC’s dam database. It is possible that some of these have fallen into a state of disrepair or neglect or may have breached or otherwise incurred structural damage in the past 50 years. It is recommended that NYSDEC conduct updated inspections of all known dams in the watershed as needed and prioritize unsafe, unsound, and otherwise deficient dams for removal or rehabilitation. Removal of all partially or substantially breached or significantly damaged dams is recommended as general practice. Priority should be based on condition, downstream hazard, ice generation, ice accumulation, and upstream backwater flooding. Rehabilitation of deficient dams should only be considered in cases of compelling need or significant and demonstrable historical or cultural value; otherwise, removal is recommended. Replacement of obsolete dams is not recommended.

Completion or maintenance of updated Engineering Assessments and Inspection and Maintenance (I&M) Plans for all Class C High Hazard and Class B Intermediate Hazard dams in the watershed is recommended; Emergency Action Plans should be developed as required for Class C dams or as requested by NYSDEC Dam Safety Section.

Some communities rely on water withdrawn from old dams on the Little Chazy River for fire suppression. In some cases, this is the only current use for the dam. Most of these dams have been recommended for removal; however, maintenance of adequate withdrawal capacity is critical. Replacement with conventional dry hydrant systems that do not require impoundment of streams and rivers has been recommended. A typical dry hydrant detail is shown in Figure 4-35.

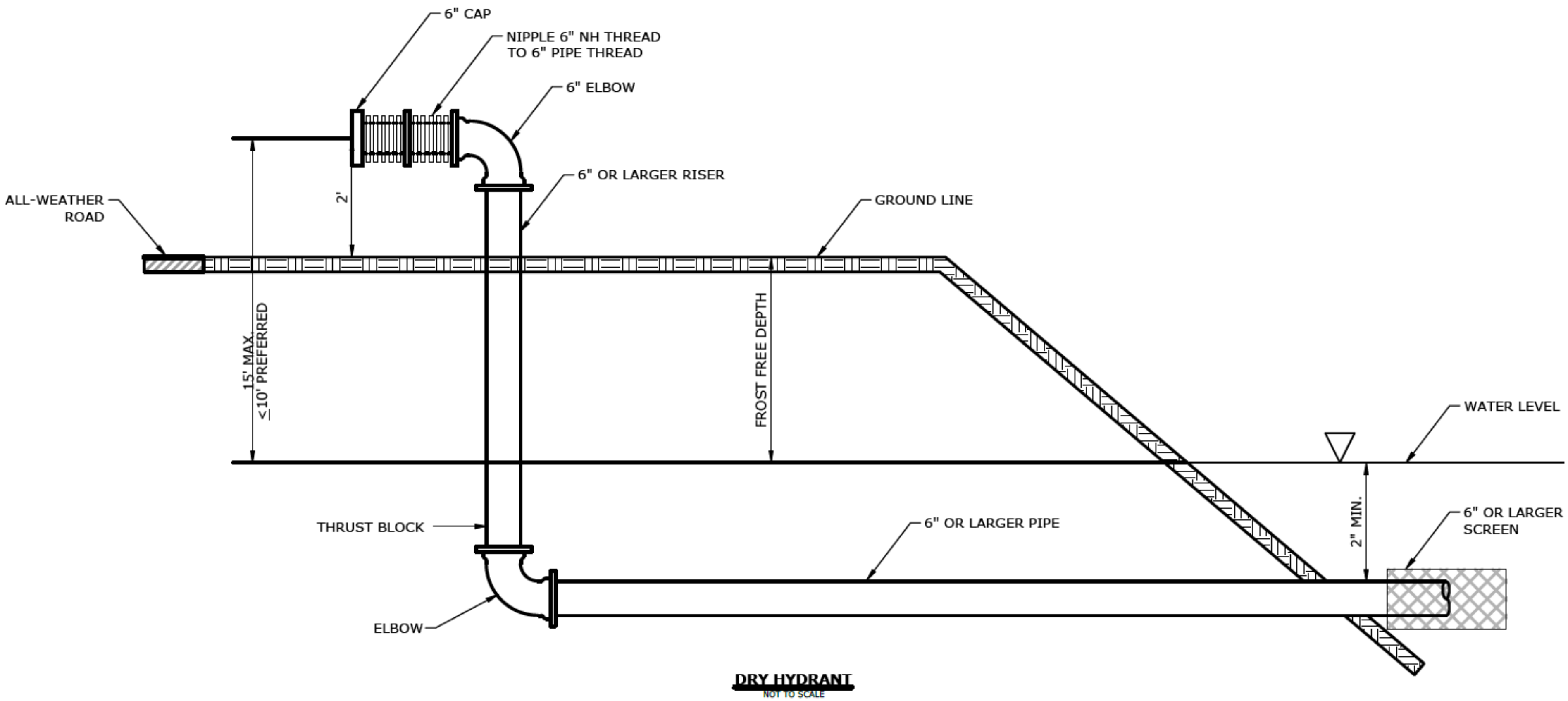


Figure 4-35: Typical Dry Hydrant Detail

4.3.1 SEA LAMPREY EXCLUSION

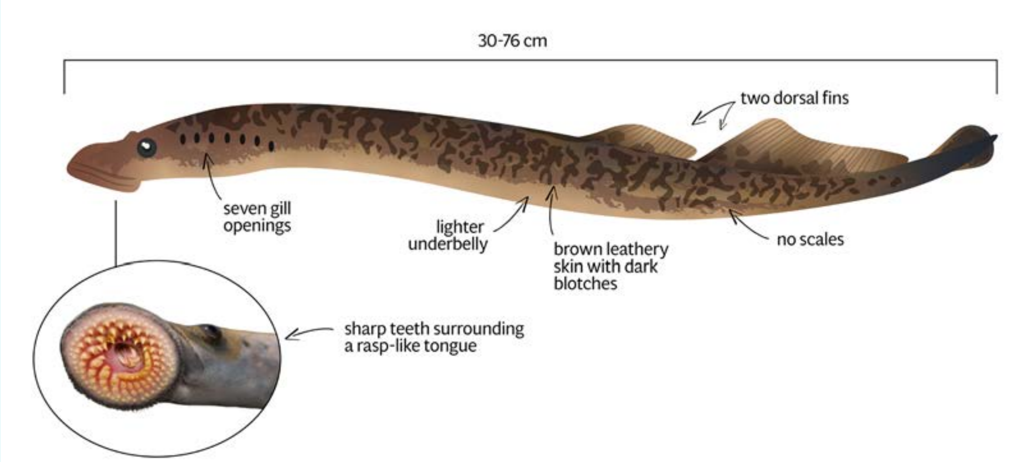
Maintenance of an effective sea lamprey barrier to inhibit migration of this invasive species upstream from Lake Champlain is an important ecological objective for NYSDEC. On the Little Chazy River, the 15-foot-high Miner Dam at STA 131+30 currently serves this purpose, although as discussed in Section 4.1, the dam is reportedly abandoned. Modification of the dam height to meet minimum acceptable criteria or replacement with a purpose-designed lamprey barrier is recommended. Requirements for restriction of lamprey passage are minor compared to the existing dam, as summarized below.

Sea Lamprey (*Petromyzon marinus*) Exclusion Criteria

- **A crest drop of 18 inches (1.5 feet) between overhanging crest and tailwater:**
  A minimum of 12 inches needs to be maintained, but 18 inches is preferable (GLFC 2014). 6 inches of overhang is sufficient. The drop could be less than 12 inches during a large flood. Vertical lamprey barriers taller than 30 cm (12 inches) are insurmountable due to lampreys' limited suction-based climbing ability (Reinhardt et al. 2009).

- **A hydraulic drop of 26 inches (2.2 feet) between upstream and downstream water surface elevations:**
  A hydraulic head of between 18 inches and 26 inches between downstream and upstream water surface elevations is considered a barrier (Katopodis et al. 1994). Multiple research papers describe the "drop" as a hydraulic drop measured between headwater and tailwater, while others describe it between crest and tailwater.

- **Velocity of 13 feet per second:**
  Spawning-run sea lampreys were found to have burst speeds of over 13 fps for short distances, possibly maintaining up to 15 fps (Hanson 1980), but that the distance and time achievable is very low (Katopodis et al. 1994). 10 fps is considered to be a high end of velocity for upstream travel.



Graphic: Canada Invasive Species Centre

5. RECOMMENDATIONS

Flood mitigation recommendations are provided either as HRA-specific recommendations or as overarching recommendations that apply to the entire watershed or stream corridor.

5.1 HRA 1 RECOMMENDATIONS

The following recommendations are provided for HRA 1:

- The Little Chazy Dam at STA 250+00 contributes both to ice formation and substantial upstream flooding, both of which can be significantly reduced with this dam's removal. Removing this dam is recommended and should be accompanied by a structural and scour assessment of the US-9 bridge just upstream. If necessary, a replacement dry hydrant system or alternative means for water withdrawal for the adjacent fire station, which does not require impoundment of the river, is recommended.

- The W.H. Miner Dam #2, located at STA 273+50, is recommended for removal. This dam contributes to flooding of roads and several properties upstream and contributes to ice formation in the winter. Removal of the dam and, if necessary, a replacement dry hydrant system for fire suppression is recommended.

- It is recommended that restoration design of floodplains within the former impoundments of the two dams listed above include ice rafting considerations to reduce the risk of damaging ice jams.

- When it is due for replacement or significant upgrade or repair, assuming the Little Chazy Dam has been removed, replacement of the state-owned US-9 bridge with a minimum 140-foot single span bridge is recommended, which would be sufficient to cross the river's projected future 100-year flood event floodplain without interference. Replacement should be accompanied by updated hydrologic and hydraulic analyses that account for projected future flows relevant to the new structure's anticipated lifetime. The new bridge should adhere to appropriate NYSDOT and NYSDEC stream crossing standards and guidelines.

- When the county-owned Fiske Road bridge is due for replacement, a minimum 80-foot single-span is recommended along with updated hydrologic and hydraulic analyses that account for projected future flows relevant to the new structure's anticipated lifetime. The new bridge should adhere to appropriate NYSDOT and NYSDEC stream crossing standards and guidelines.

- Three low-head dams impound the Little Chazy River downstream of the Miner Dam in the hamlet of Chazy at STA 241+10, STA 244+50, and STA 247+50. These structures are not included in the NYSDEC dam inventory. Inspection of the three dams for inclusion in the database is recommended.

- The three low-head dams at STA 241+10, STA 244+50, and STA 247+50, and what is presumed to be the Fordhams Mills dam at STA 198+00, appear to be obsolete, and their removal is recommended.

5.2 HRA 2 RECOMMENDATIONS

The following recommendations are provided for HRA 2:

- The Canadian Pacific railroad crossing (STA 768+50) is severely undersized and has apparently experienced abutment scour in the past; replacement with a minimum 90-foot single span is recommended along with updated hydrologic and hydraulic analyses that account for projected future flows relevant to the new structure's anticipated lifetime.

- The NY-22 bridge (STA 779+50) has the capacity to convey up to the current 100-year flood event under clear water conditions, largely due to the river's steep slope at this location, but the bridge constricts the channel significantly, making it prone to jamming with debris or ice. The bridge deck is expected to overtop in the projected future 100-year flood event. At the end of this bridge's service life, or when due for significant upgrade or repairs, replacement of this crossing with a minimum 60-foot single-span bridge is recommended along with updated hydrologic and hydraulic analyses that account for projected future flows relevant to the new structure's anticipated lifetime. The new bridge should adhere to appropriate NYSDOT and NYSDEC stream crossing standards and guidelines.

- Inclusion of the NY-22 bridge (STA 779+50) in the NBI is recommended.

- The West Chazy Dam (STA 780+00) is in poor condition. It is recommended that this dam be removed and the natural bedrock falls at this location be restored. It is recommended that the existing dry hydrant be replaced with a comparable system that does not rely on this dilapidated dam.

- It is recommended that the West Church Street crossing (STA 786+50) be replaced with minimum 90-foot single-span bridge, to be accompanied by restoration of the entrenched channel and minor floodplain enhancements upstream and downstream of the crossing. This includes regrading of about 300 feet of the vertically walled right bank to a more natural bank slope of 2H:1V and excavation of between 1 foot and 4 feet along a roughly 400-foot-long, 25-foot-wide strip of connected floodplain along the left bank. Bridge replacement should be accompanied by updated hydrologic and hydraulic analyses that account for projected future flows relevant to the new structure's anticipated lifetime. The new bridge should adhere to appropriate NYSDOT and NYSDEC stream crossing standards and guidelines.

- It is recommended that NYSDEC reconsider classification of the Altona Flat Rock Dam (STA 1041+00) as a Class D Negligible or No Hazard dam as it appears to present a potential hazard.

- Breach and removal of the Altona Flat Rock Dam (STA 1041+00) is recommended to permit unrestricted passage of flood flows and geomorphological and ecological processes as well as to eliminate the hazard this dam poses to downstream life safety, infrastructure, and property.

- It is recommended that the "Skeleton Dam" (STA 1117+50), which was partially constructed but abandoned before completion, be inspected by NYSDEC for inclusion in the current dam inventory.

- It is recommended that the "Skeleton Dam" (STA 1117+50) be removed.

5.3 REMOVAL OF OBSTRUCTIONS TO FLOW

In addition to the dams and other structures evaluated and discussed in HRA 1 and HRA 2 above, removal of obsolete or damaged structures from the stream channel is recommended as general practice. This includes substructural elements of old bridges such as piers and abutments, which were not removed when the crossing was relocated or abandoned. These features contract flows, snag debris and ice, and in some cases are public safety hazards.

Dams that were observed in the field or in aerial photographs that are not included in the NYSDEC dam inventory are tabulated in Table 5-1 along with pertinent identifying information. It is recommended that these dams be inspected for inclusion in the database. These structures are also recommended for removal.

Table 5-1 Dams Not Found in NYSDEC Dam Inventory (February 2021 Revision). Horizontal Datum: NAD83 NY State Plane East

RIVER STATION	NORTHING (FT)	EASTING (FT)	DESCRIPTION	MAPPING
241+10	2209290	767890	Low-head concrete dam downstream of Little Chazy Dam in Chazy Hamlet	Figure 4-2C
244+50	2208980	767790	Low-head concrete dam downstream of Little Chazy Dam in Chazy Hamlet	Figure 4-2C
247+50	2208695	767785	Low-head concrete dam downstream of Little Chazy Dam in Chazy Hamlet	Figure 4-2C
1117+50	2193000	728150	Partially completed 700-foot-long concrete slab and buttress dam in Altona. Locally known as "Skeleton Dam"	Figure 4-29A, Figure 4-29B

As an interim step prior to dam removal, it is recommended that a dam removal feasibility study be undertaken at each site to further refine the cost and level of effort required for removal.

A number of intact but abandoned or derelict bridges also span the Little Chazy River and its tributaries. These should be removed or made sound and rehabilitated if there is a compelling reason to do so such as significant historic value.

It is recommended that NYSDEC ascertain the current owners of dams in the watershed and, with all dams in the watershed as appropriate, take necessary action to enforce the responsibilities of dam ownership set forth in 6 NYCRR Part 673 and Environmental Conservation Law (ECL) § 15-0507.

Completion or maintenance of updated Engineering Assessments and Inspection and Maintenance (I&M) Plans for all Class C High Hazard and Class B Intermediate Hazard dams in the watershed is recommended; Emergency Action Plans should be developed as required for Class C dams or as requested by NYSDEC Dam Safety Section.

Replacement of dams used for fire suppression with conventional dry hydrant systems that do not require impoundment of streams and rivers is recommended.

Maintenance of an effective sea lamprey barrier to inhibit migration of this invasive species upstream from Lake Champlain is an important ecological objective for NYSDEC. On the Little Chazy River, the 15-foot-high Miner Dam at STA 131+30 currently serves this purpose. Modification of the dam height to meet minimum acceptable criteria or replacement with a purpose-designed lamprey barrier is recommended.

5.4 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 specific stream crossings within HRA 1 and HRA 2 described above, it is recommended that undersized stream crossings elsewhere in the Little Chazy watershed be identified and prioritized for replacement. Guidance for this prioritization can be based on known chronic flooding issues, capacity modeling, and aquatic organism passage criteria.

Bridges and culverts that are currently adequate may not have the capacity for projected future flow scenarios, so in-kind replacement is generally not recommended without accompanying hydrologic and hydraulic analyses to support this decision. Regardless of past bridge performance and flooding history, all replacement stream crossings should be accompanied by rigorous, up-to-date hydrologic and hydraulic analyses and incorporate the most current future flood projections and all applicable design standards and guidance set forth by NYSDOT and NYSDEC, as practical. Hydraulic design criteria developed by these agencies are presented in Section 2.7. Where multiple stream crossings are slated for replacement along a reach of watercourse, it is recommended that replacements begin at the downstream end and progress sequentially in an upstream direction.

5.5 STREAM GAUGING

Continued operation of the existing USGS stream gauging station on the Little Chazy River is recommended.

5.6 DOCUMENTATION OF HIGH WATER MARKS

To make risk assessments for flooding events, certain types of data are needed. This data consists of physical evidence such as High Water Marks (HWMs) left by a flood event. Often, HWM evidence is transitory and can only be collected within a short span of time after an event, after which the evidence disappears. The HWM is the most important piece of information to describe the severity of a flood, and it is essential that HWMs are recorded quickly after a flood event but only if it can be done safely. If precise survey cannot be obtained, photographs of HWM on permanent structures, with ruler or tape measure for scale, can be valuable as the measurement can later be replicated.

5.7 PROPERTY RELOCATIONS

High-level conceptual relocation "Master Plans" of potential relocation areas for homes in identified HRAs are presented in their respective sections. These are based on identification of areas where relocation generally seems to make sense for residential, retail/commercial, industrial, and other land uses having a potential to flood through this assessment. Any relocation efforts will require significant coordination between landowners eligible for relocation, landowners interested in selling land for new development, local government input, and requirements and regulations by funding and assistance agencies from the state to federal levels.

The following are general criteria and assumptions utilized in undertaking this exercise:

- The parcels identified as potentially needing to be relocated were based on a review of Geographic Information System (GIS) data. Identified parcels either had the floodplain boundary covering an actual structure or in close proximity based in part on topography as assessed using mapping software.

- Relocation sites were located using the following criteria:
  - Locations must be well outside of the 100-year floodplain.
  - Locations have been selected to provide immediate access to a major road.
  - Natural and environmental features are to be preserved to the greatest extent possible. Lots for relocation should require minimal tree removal, if any, and avoid steep slopes.
  - Locations were identified based on development potential by reviewing visual landscape characteristics. No owner contact or discussion with local municipalities regarding zoning has been undertaken for this exercise. The likely density calculation was based on assessing nearby lot sizes using GIS.
  - Sites were selected to minimize fragmenting existing parcels.
  - Sites were selected to minimize the loss of agricultural land.
  - The potential buildout calculation for each site began with a 25 percent land area reduction for consideration of utilities, roads, and natural features constraints and to provide a generally conservative estimate of the development potential of each site.

- Potential developable areas are shown by a proportional shape – the larger the circle the larger the parcel or developable area.
- Land Use Classification Codes used for potential redevelopment sites excluded those that are recorded in the GIS system as active agricultural land.

5.8 INDIVIDUAL PROPERTY FLOOD PROTECTION

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

Elevation of the structure – Home elevation involves the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located at least 2 feet above the level of the 100-year flood event. The basement area is abandoned and filled to be no higher than the existing grade. All utilities and appliances located within the basement must be relocated to the first-floor level or installed from basement joists or similar mechanism.

Construction of property improvements such as barriers, floodwalls, and earthen berms – Such structural projects can be used to prevent shallow flooding. There may be properties within the basin where implementation of such measures will serve to protect structures.

Dry floodproofing of the structure to keep floodwaters from entering – Dry floodproofing refers to the act of making areas below the flood level watertight and is typically implemented for commercial buildings that would be unoccupied during a flood event. Walls may be coated with compound or plastic sheathing. Openings such as windows and vents can be either permanently closed or covered with removable shields. Flood protection should extend only 2 to 3 feet above the top of the concrete foundation because building walls and floors cannot withstand the pressure of deeper water.

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

Performing other home improvements to mitigate damage from flooding – The following measures can be undertaken to protect home utilities and belongings:

- Relocate valuable belongings above the 100-year flood elevation to reduce the amount of damage caused during a flood event.
- Relocate or elevate water heaters, heating systems, washers, and dryers to a higher floor or to at least 12 inches above the BFE (if the ceiling permits). A wooden platform of pressure-treated wood can serve as the base.

- Anchor the fuel tank to the wall or floor with noncorrosive metal strapping and lag bolts.
- Install a backflow valve to prevent sewer backup into the home.
- Install a floating floor drain plug at the lowest point of the lowest finished floor.
- Elevate the electrical box or relocate it to a higher floor and elevate electric outlets.

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

5.9 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 Great Chazy 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 and highway departments are often the best resource for identifying priority areas and repetitively damaged infrastructure.

5.10 ROUGH ORDER OF MAGNITUDE COST RANGE OF RECOMMENDED ACTIONS

To assist with planning and prioritization of the above recommendations, Table 5-2 provides an estimated rough order of magnitude cost range for key recommendations. Due to the conceptual nature of recommended actions and significant amount of data required to produce a reasonable rough-order-of-magnitude cost, it is not feasible to further quantify the costs of these actions. Costs of land acquisition or easements are not included in the costs.

Table 5-2 Rough Order of Magnitude Cost Range of Recommended Actions

	< $100k	$100k - $500k	$500k - $1M	$1M - $5M
HRA 1 Remove/modify/replace Miner Dam (maintain sea lamprey barrier)[1]		X		
HRA 1 Remove Chazy Dam incl. structural assessment of US-9 bridge[1]			X	
HRA 1 Remove WH Miner Dam #2[1]		X		
HRA 1 Remove additional obsolete low head dams (each) [1]		X		
HRA 2 Replace NY-22 bridge (minimum 60’ span)				X
HRA 2 Remove West Chazy Dam; replacement of fire suppression water withdrawal appurtenances[1]			X	
HRA 2 Replace West Church Street bridge (minimum 90’ span), adjacent channel restoration				X
HRA 2 Breach/remove Altona Flat Rock Dam[1]				X
HRA 2 Remove “Skeleton” Dam[1]			X	
Removal of dams and other structures[1]		X		
Dam removal feasibility study ($12,000 to $18,000 per dam)	X			

1 - Cost of dam removal implementation will vary depending on quality and quantity of impounded sediment, need for grade control or scour protection measures at upstream crossings, construction accessibility, and other design considerations.

5.11 FUNDING SOURCES

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

Emergency Watershed Protection (EWP) Program

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

FEMA Pre-Disaster Mitigation (PDM) Program

The PDM program was authorized by Part 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 U.S.C. 5133. The PDM program provides funds to states, territories, tribal governments, communities, and universities for hazard mitigation planning and implementation of mitigation projects prior to disasters, providing an opportunity to reduce the nation's disaster losses through PDM planning and the implementation of feasible, effective, and cost-efficient mitigation measures. Funding of pre-disaster plans and projects is meant to reduce overall risks to populations and facilities. The PDM program is subject to the availability of appropriation funding as well as any program-specific directive or restriction made with respect to such funds.
https://www.fema.gov/pre-disaster-mitigation-grant-program

FEMA Hazard Mitigation Grant Program (HMGP)

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

The HMGP is one of the FEMA programs with the greatest possible fit to potential projects recommended in this report. However, it is available only in the months subsequent to a federal disaster declaration in the State of New York. Because the state administers the HMGP directly, application cycles will need to be closely monitored after disasters are declared in New York.
https://www.fema.gov/hazard-mitigation-grant-program

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

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

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

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

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

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

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

- Capital Investment in Facilities and Equipment

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

U.S. Army Corps of Engineers (USACE)

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

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

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

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

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

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

New York State Grants

All New York State grants are now announced on the NYS Grants Gateway. The Grants Gateway is designed to allow grant applicants to browse all NYS agency anticipated and available grant opportunities, providing a one-stop location that streamlines the way grants are administered by the State of New York. Examples of grant programs include the NYSDEC's Climate Smart Communities Grant program and the New York State Environmental Facilities Corporation's Green Innovation Grant Program.

https://grantsmanagement.ny.gov/

Bridge NY Program

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

https://www.dot.ny.gov/BRIDGENY.

Lake Champlain Basin Program

The Lake Champlain Basin Program is a Congressionally designated initiative to restore and protect Lake Champlain and its surrounding watershed. The program with partners in New York, Vermont, and Québec to coordinate and fund efforts to address challenges in the areas of phosphorus pollution, toxic substances, biodiversity, aquatic invasive species, and climate change.

https://www.lcbp.org/about-us/grants-rfps/

Private Foundations

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

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

Land Trust and Conservation Groups

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

Communities will need to work closely with potential funders to ensure that the best combinations of funds are secured for the proposed alternatives and for the property-specific mitigation such as floodproofing, elevations, and relocations. It will be advantageous for the communities to identify combinations of funding sources in order to reduce their own requirement to provide matching funds.

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