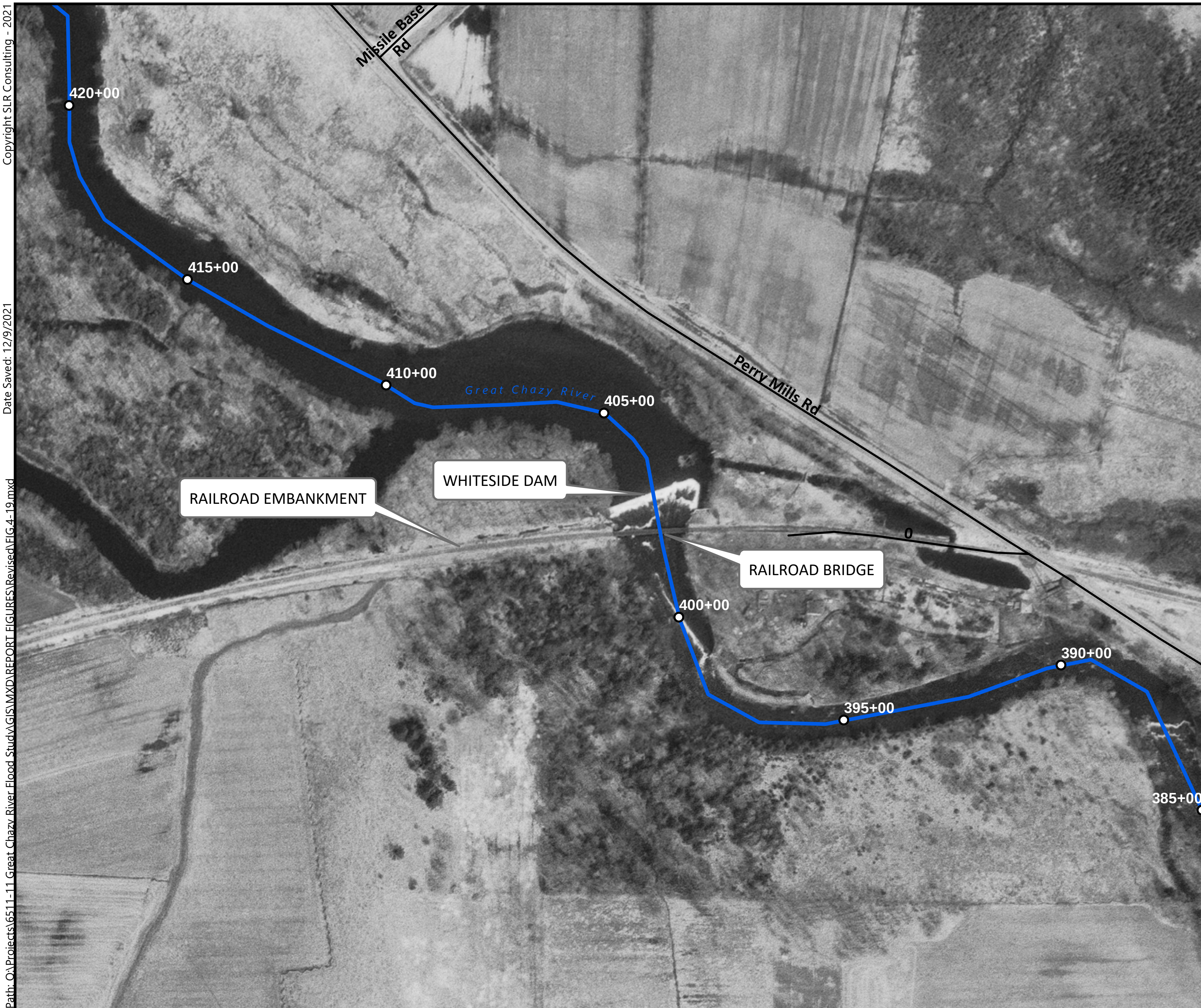

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231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HRA #2 - WHITESIDE DAM (1964 AERIAL IMAGE)

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

SCALE 1 " = 300 '

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FIG. 4-19

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NEW PALTZ, NY 12561
845.633.8153

HRA #2 - WHITESIDE DAM (2020 AERIAL IMAGE)

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY

SD119

CLINTON COUNTY
NEW YORK

SCALE 1 " = 300 '

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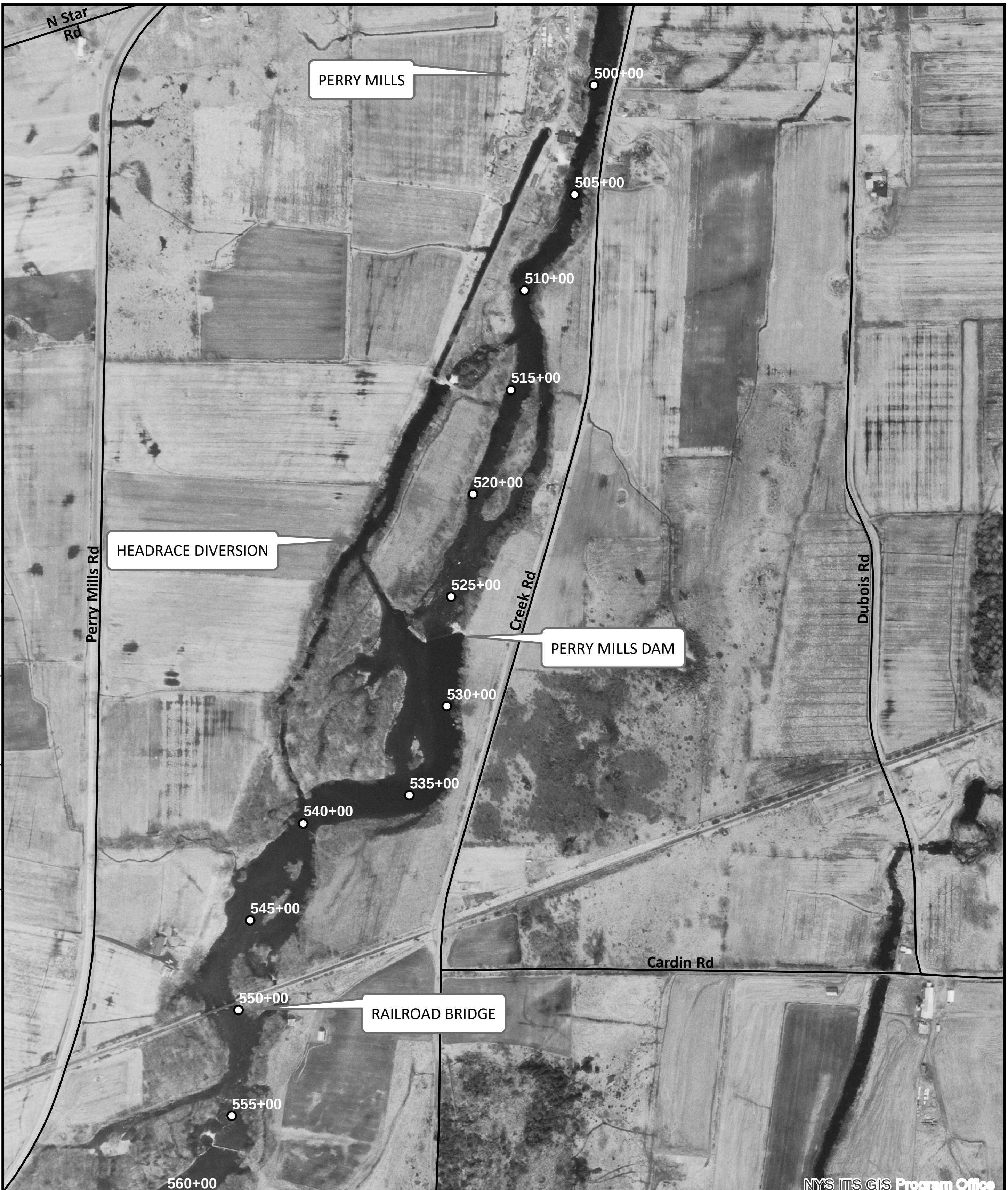
FIG. 4-20



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NEW PALTZ, NY 12561
845.633.8153

HRA #2 - PERRY MILLS DAM (1964 AERIAL IMAGERY)

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

SCALE 1 " = 600 '
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FIG. 4-21

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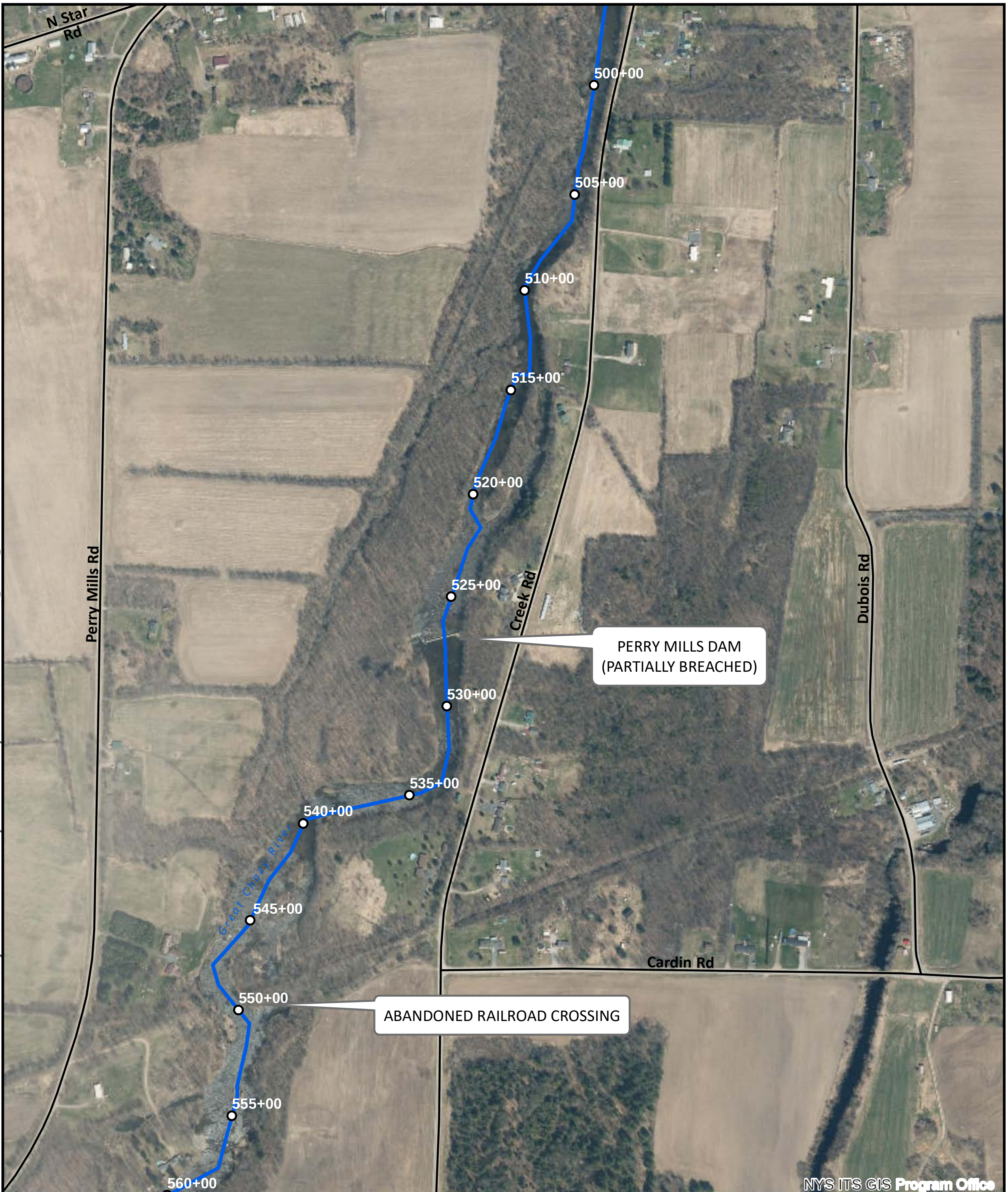

SLR
231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HRA #2 - PERRY MILLS (2020 AERIAL IMAGERY)
GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

SCALE 1 " = 600 '
DATE 1/5/2022
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FIG. 4-22

The Whiteside Dam acts as a source of excess ice generation as well as stagnation and jamming upstream. Within the impoundment, ice is thicker, and formation can begin earlier in the winter since the water is relatively still and calm. As break-up ice floes move downstream, they can snag in the shallows caused by aggradation at the head of the impoundment and/or be stopped by the solid, thick layer of ice formed behind the dam, which is likely to be anchored to the bed in shallower areas. The ice then builds upstream, affecting properties and roadways and threatening the Creek Road bridge at Perry Mills (NBI BIN: 3336210), where ice can jam further. This phenomenon is illustrated by the aerial imagery collected by the Clinton County Emergency Services Department in March 2007, shown in Figures 4-23 through 4-26.

Figure 4-23: Break-up ice accumulates at the solid ice that forms in the tailwaters of Whiteside Dam – note transition at image center. View is to the east, looking downstream; Dubois Road is in foreground. Image is provided by Clinton County Department of Emergency Services.

Figure 4-24: Solid ice in the Whiteside Dam impoundment. View is to the east, looking downstream; CR-17 runs along the left bank. Image is provided by Clinton County Department of Emergency Services.

Figure 4-25: Ice jamming extends through the Creek Road bridge in Perry Mills. View is looking northwest; flow is left to right in image. Image is provided by Clinton County Department of Emergency Services.

Figure 4-26: Break-up ice jamming in March 2007 at the Creek Road bridge in Perry Mills. View is up upstream face of bridge; flow is right to left in image. Image is provided by Clinton County Department of Emergency Services.

Wide-river ice jamming and dynamic-bridge ice jamming were simulated in the HEC-RAS hydraulic model developed for this study. Based on input parameters gleaned from descriptions and photographs of past ice jams, an ice-affected bankfull discharge was simulated under the conditions described above and without the presence of the dam. Ice jamming at the Creek Road bridge can be mitigated by removing or lowering the spillway crest of the Whiteside Dam downstream, as shown in Figures 4-27, 4-28, and 4-29. NYSDEC Region 5 Fisheries staff indicate that per their and USFWS analysis, the existing bedrock falls at the dam would not constitute an effective lamprey barrier in themselves and that the dam is currently undergoing repairs to improve lamprey exclusion efficacy. Modification to reduce the spillway crest elevation by as much as practical for lamprey exclusion is recommended, or replacement with a new barrier specifically designed for this purpose. It would then be recommended to maintain the overbank areas within the former or reduced impoundment as readily accessible ice-rafting meadows for storage of break-up ice.

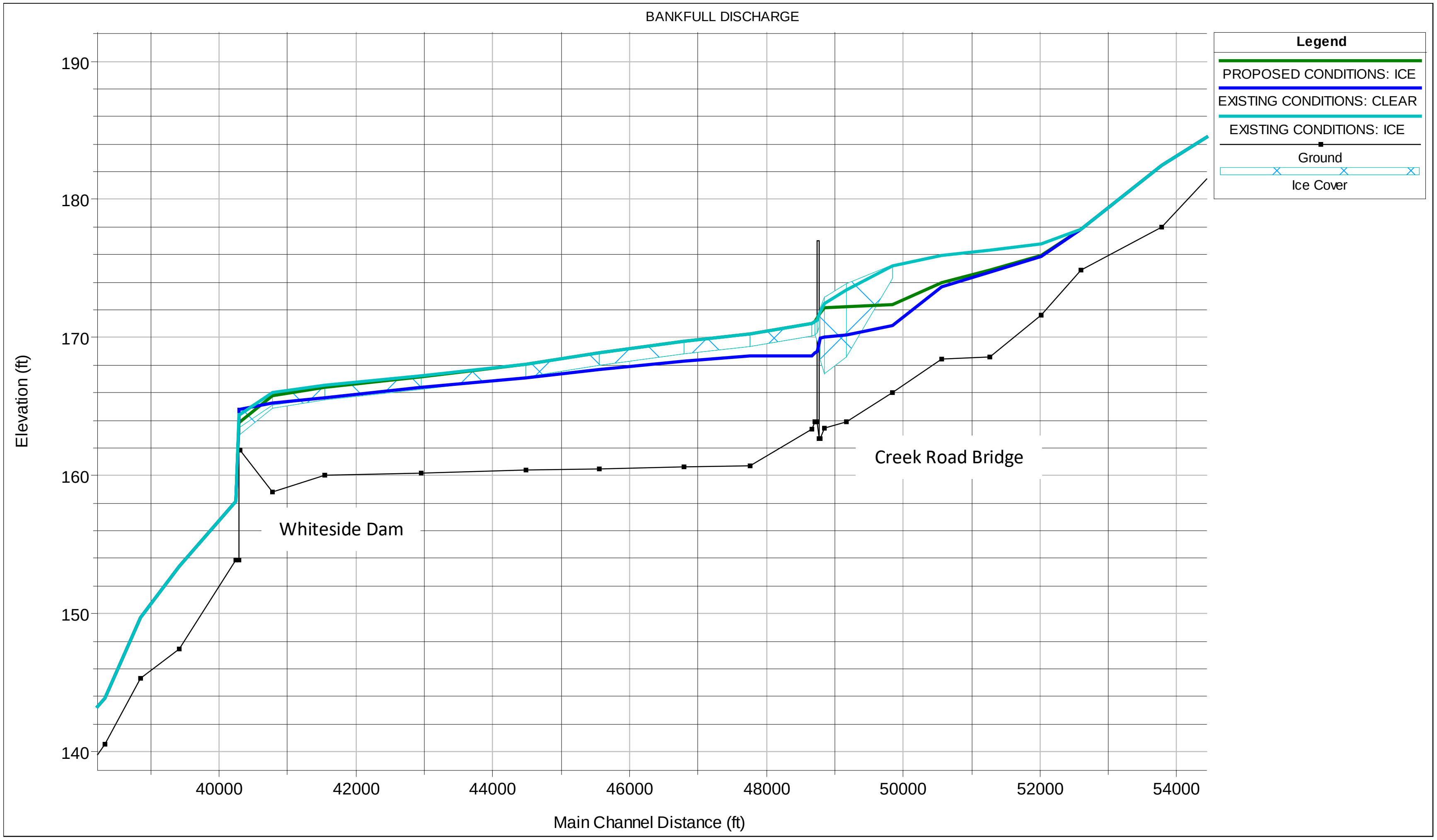
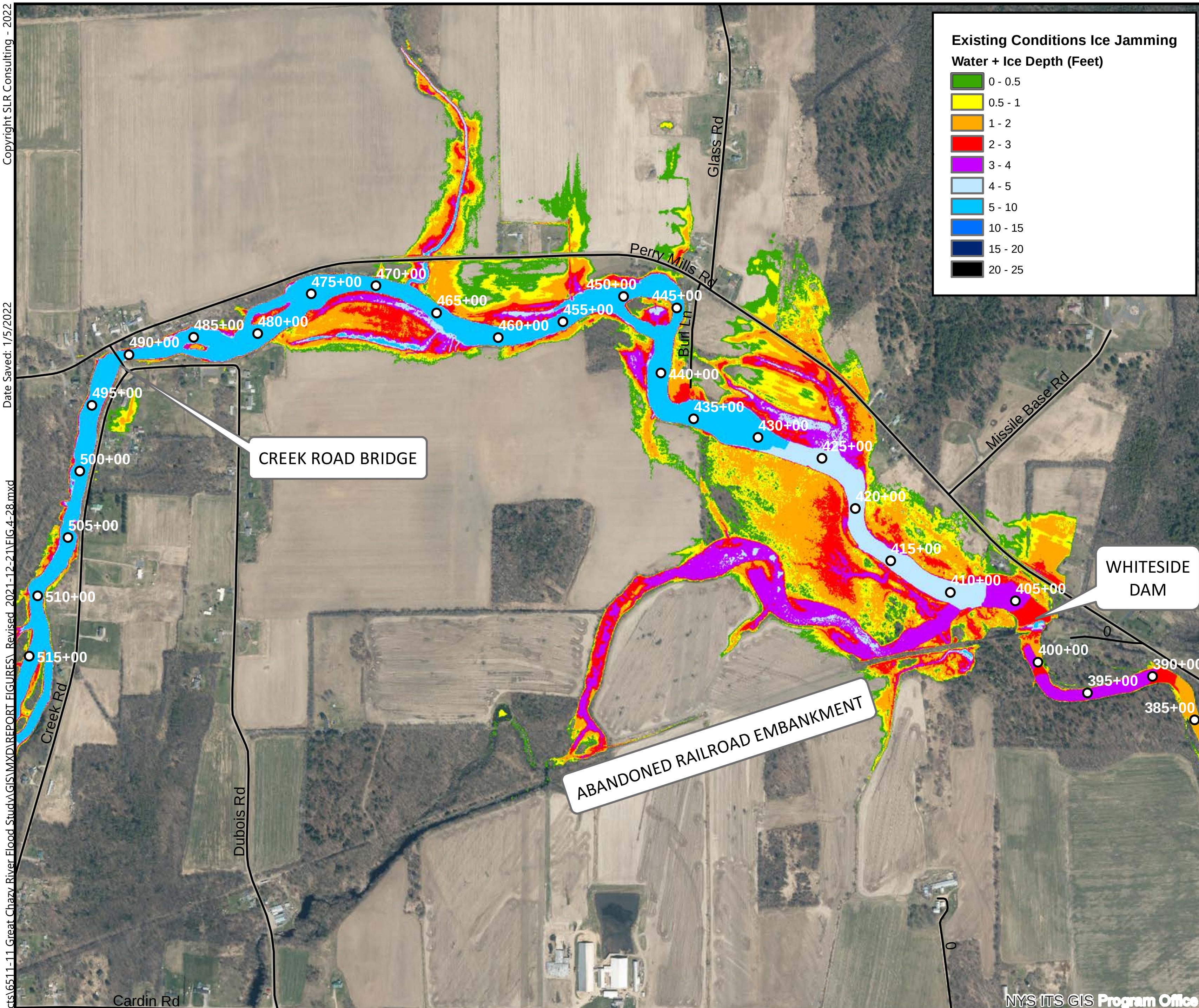


Figure 4-27: Profile of Modeled Bankfull Flow Through Perry Mills Under Ice Jamming Scenarios Comparing Existing Conditions and Proposed Conditions, with Whiteside Dam Removed and No Ice Accumulation.



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NEW PALTZ, NY 12561
845.633.8153

HRA #2 - BANKFULL FLOW ICE JAM - EXISTING CONDITIONS
GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

SCALE 1 " = 1,000 '
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FIG. 4-28

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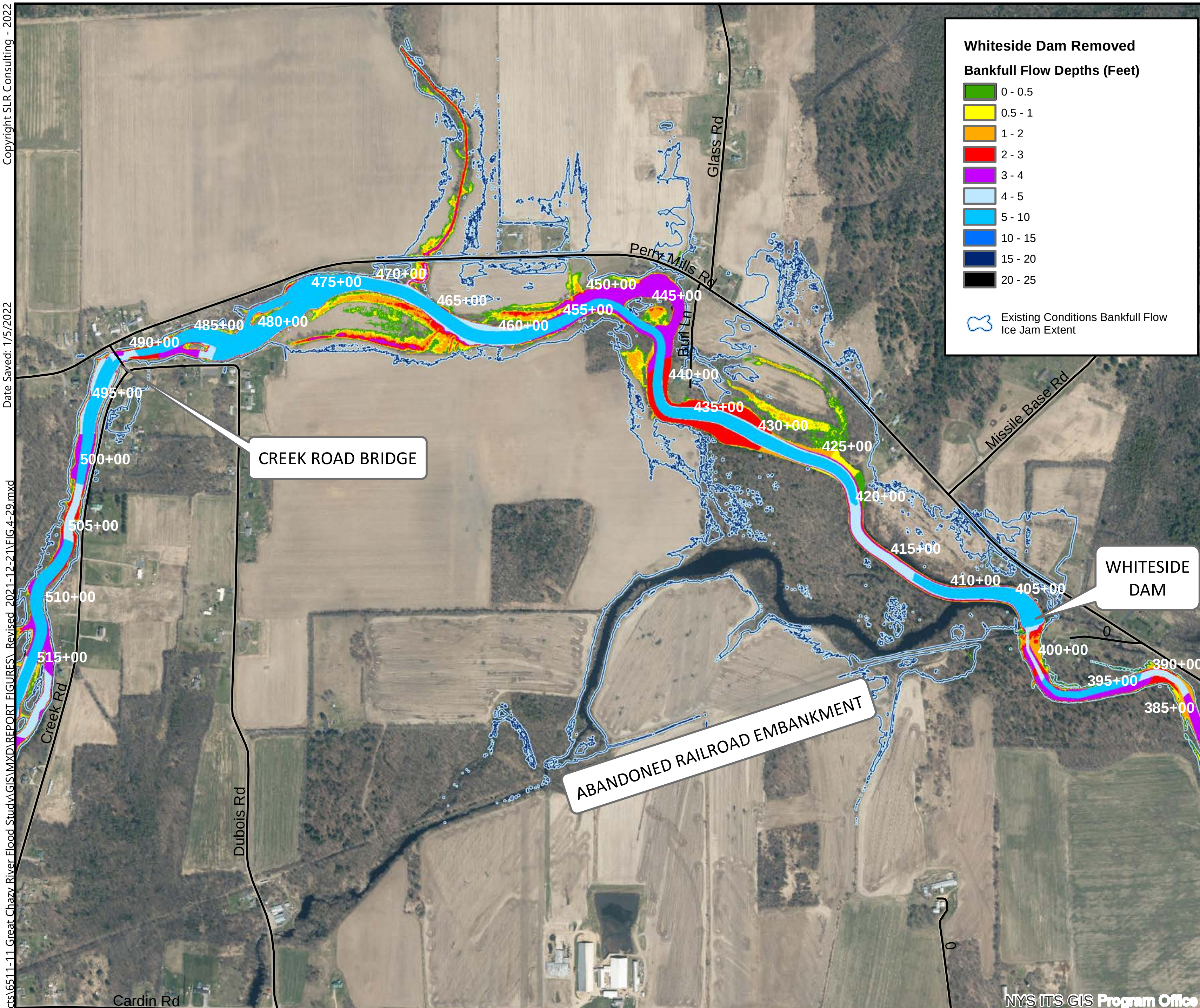

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231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HRA #2 - BANKFULL FLOW - WHITESIDE DAM REMOVED

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY

SD119

CLINTON COUNTY
NEW YORK

SCALE 1 " = 1,000 '

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FIG. 4-29

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Potential relocations of flood-prone properties within HRA 2 unrelated to proposed flood and ice jam mitigation projects were also explored. Approximately 50 residential properties were identified as potentially needing to be relocated. These properties are not necessarily fully within a floodplain area – many parcels are only partially within a floodplain or adjacent to the edge of a floodplain. The 100-year flood hazard at up to ten of these properties may be alleviated or substantially reduced with the proposed Creek Road bridge replacement and Whiteside Dam modifications.

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.

Potential relocation sites were identified totaling 151 acres. Based on the analysis criteria utilized to calculate lot buildout, these parcels could provide relocation sites for all 50 residential lots or more at a density generally consistent with the densities in the areas of each relocation site, utilizing existing cleared land area only. 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 50 residential uses and 0 nonresidential uses were identified as potentially needing to be relocated.

1) 1 parcel consisting of ~4 acres. Residential development potential – likely medium density (~1-acre minimum lot size). Access to Dubois Road. Three or more residential lots, depending on the density and site design, could likely be developed. The parcel is largely cleared. The parcel is classified rural vacant > 10 acres.
2) 1 parcel consisting of ~9 acres. Residential development potential – likely medium density (~1-acre minimum lot size). Access to Dubois Road. Seven or more residential lots, depending on density and site design, could likely be developed. The parcel is largely cleared. The parcel is classified rural vacant < 10 acres.
3) 1 parcel consisting of ~46 acres. Residential development potential – likely medium density (~1-acre minimum lot size). Access to Creek Road and Dubois Road. Ten or more residential lots on the cleared portion of the site only, depending on density and site design, could likely be developed. Significantly more could be developed if the site was cleared further. The parcel is approximately 1/5 cleared. The parcel is classified vacant with improvements.
4) 1 parcel consisting of ~92 acres. Residential development potential – likely medium density (~1-acre minimum lot size). Access to Perry Mills Road. Sixty-nine or more residential lots, depending on density and site design, could likely be developed. The parcel is largely cleared though it is a flag lot with minimal frontage on Perry Mills Road. The parcel is classified as abandoned agriculture.

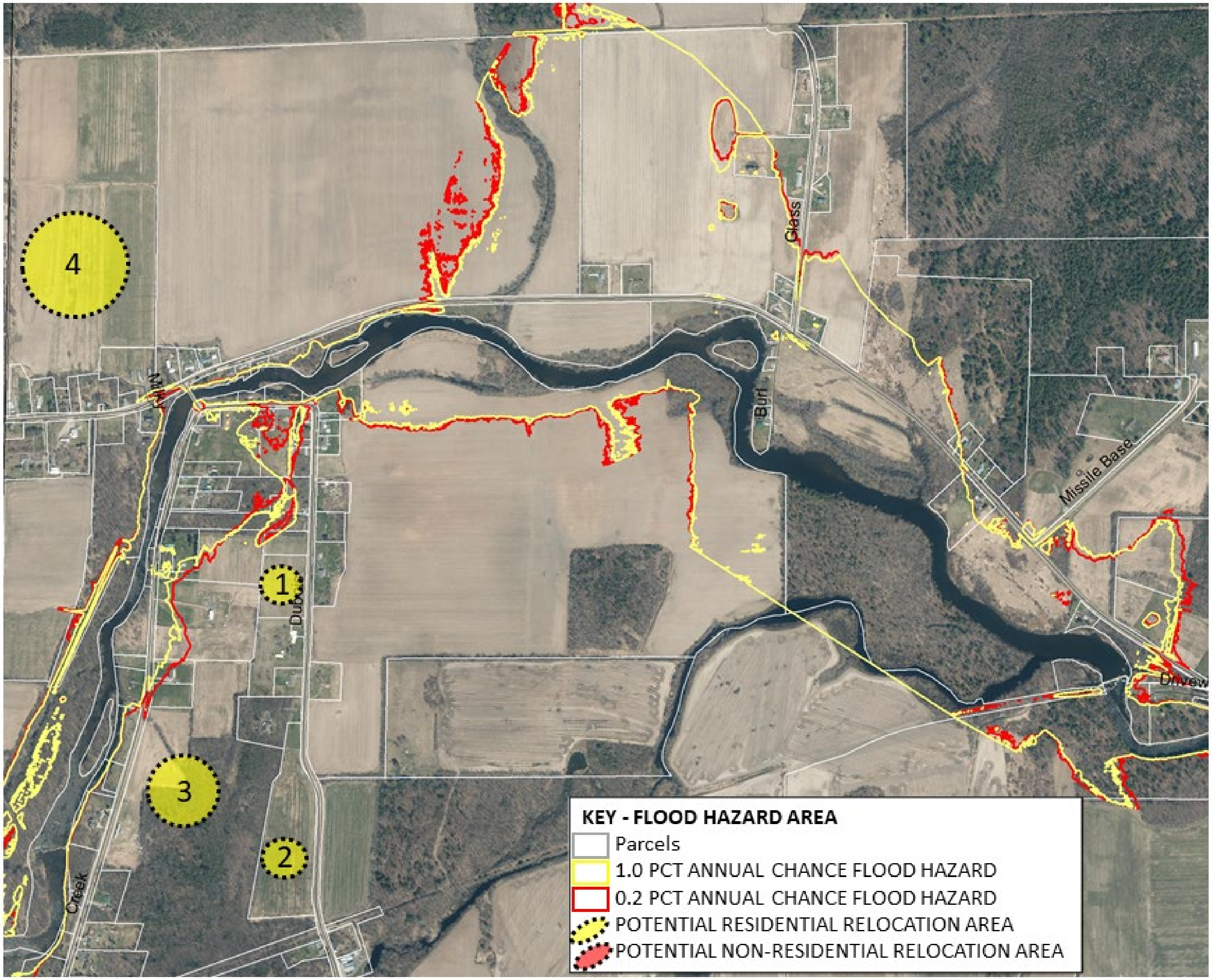


Figure 4-30: Conceptual redevelopment location mapping for HRA 2. See inset above for descriptions.

Zoning and planning considerations for the Hamlet of Perry Mills are included in the Town of Champlain documents discussed in Section 4.1.

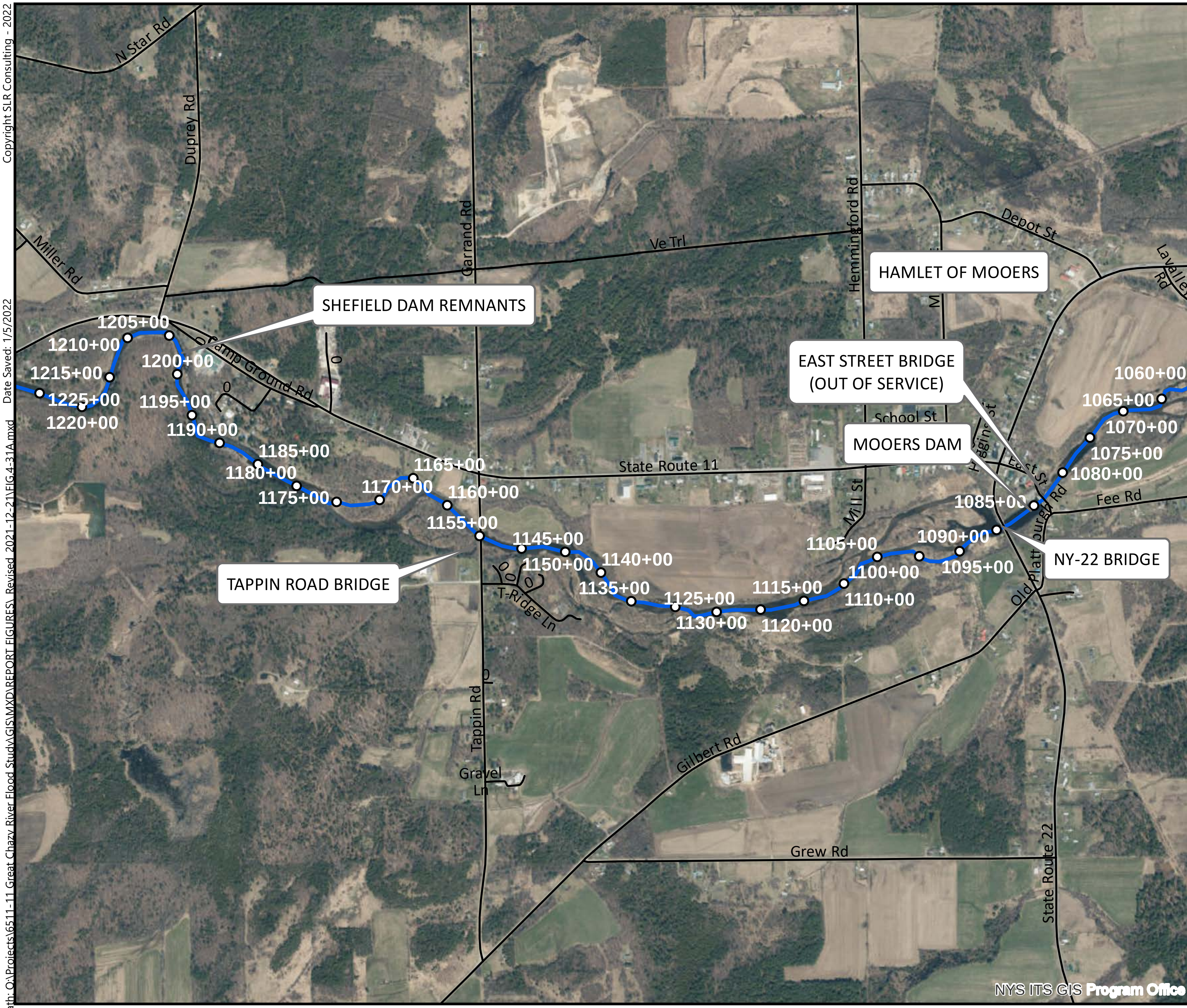
4.3 HIGH RISK AREA 3 – HAMLET OF MOOERS

HRA 3 is located in and around the hamlet of Mooers, extending downstream to the out-of-service East Street bridge at STA 1084+00 and upstream to the remains of the Shefield Dam near the intersection of US-11 and Duprey Road at STA 1205+00. The area is shown in Figures 4-31A and 4-31B. Three bridges span the Great Chazy River within HRA 3: the county-owned steel truss CR-34/East Street bridge at STA 1084+00, which is currently closed to vehicular and pedestrian traffic, having been functionally replaced by the state-owned NY-22 bridge about 500 feet upstream at STA 1089+00, and the county-owned Tappin Road bridge at STA 1155+00, which was replaced in 2020-2021.

The hamlet of Mooers is a small crossroads community along mostly the north side of the Great Chazy River in the town of Mooers. Mooers is located at the intersection of State Route 11 and County Route 22. Main Street includes a mix of residential and commercial uses with primarily residential land uses on roads extending off Main Street. The Mooers Elementary School is located in the hamlet but over 500 feet from the closest edge of a floodplain. Flood-prone areas include residences, mixed-use residential land, agriculture, and vacant land. No critical facilities were identified in the floodplain.

The following land use types are found within HRA 3: Tax Classification Codes 100 – Agricultural, 200 – Residential, 300 – Vacant Land, 400 – Commercial, 600 – Community Services, and 800 – Public Services.

The CR-34/East Street bridge (NBI BIN: 3336250) is a steel Whipple thru truss bridge originally built in 1888, rehabilitated in 1960, and abandoned in 1983 when it was replaced by the NY-22 bridge that crosses the Great Chazy River 500 feet upstream (NBI BIN: 1017310). The bridge is currently closed to all traffic. During field investigations, deterioration of the protective paint was observed on the bridge's structural steel, which shows signs of corrosion as seen in Figure 4-32. The river channel has a relatively steep profile at this crossing due to a bedrock cascade, and hydraulic modeling demonstrates that while this bridge does cause a slight flow contraction it does not contribute to significant upstream flooding and has more than 10 feet of freeboard in the 100-year flood. If this bridge is to remain (e.g., for historical significance), it is critical that it be maintained in good condition to avoid potential hazards developing in the future. Rehabilitation of this bridge (e.g., as a pedestrian crossing) and regular inspection and maintenance are recommended if is to be preserved; otherwise, it is recommended that the bridge be removed.



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

HIGH RISK AREA #3 - HAMLET OF MOOERS

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY

SD119

CLINTON COUNTY
NEW YORK

SCALE 1 " = 1,500 '

DATE 1/5/2022

PROJ. NO. 16511.00011

FIG. 4-31A

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SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HIGH RISK AREA #3 - HAMLET OF MOOERS

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY

SD119

CLINTON COUNTY

NEW YORK

SCALE 1 " = 400 '

DATE 1/5/2022

PROJ. NO. 16511.00011

FIG. 4-31B

Figure 4-32: Out-of-service East Street bridge in the Hamlet of Mooers. Note deterioration of protective paint on the steel trusses and signs of corrosion.

Just upstream of the defunct East Street bridge in the hamlet of Mooers, a low-head dam is present at STA 1084+50, shown in Figure 4-33 ("Mooers Dam;" NYSDEC: ID 217-2145; Federal ID: NY13638). According to NYSDEC's dam database, this is a 6-foot-high, Class A Low Hazard dam built in 1954 and owned by the hamlet. It was last inspected in 2009, and its condition is currently not rated although numerous seeps were observed in the concrete gravity dam during field investigations. Hydraulic modeling shows that this dam causes 3.7 feet of increase in upstream flood depths in the 10-year flood and 2.8 feet of additional backwater flooding in the 100-year flood. The dam's right training wall is shown to overtop beginning in the 10-year flood, indicating inadequate spillway performance and exposure to loads in excess of design, which can increase hazards to downstream life safety, infrastructure, and property.

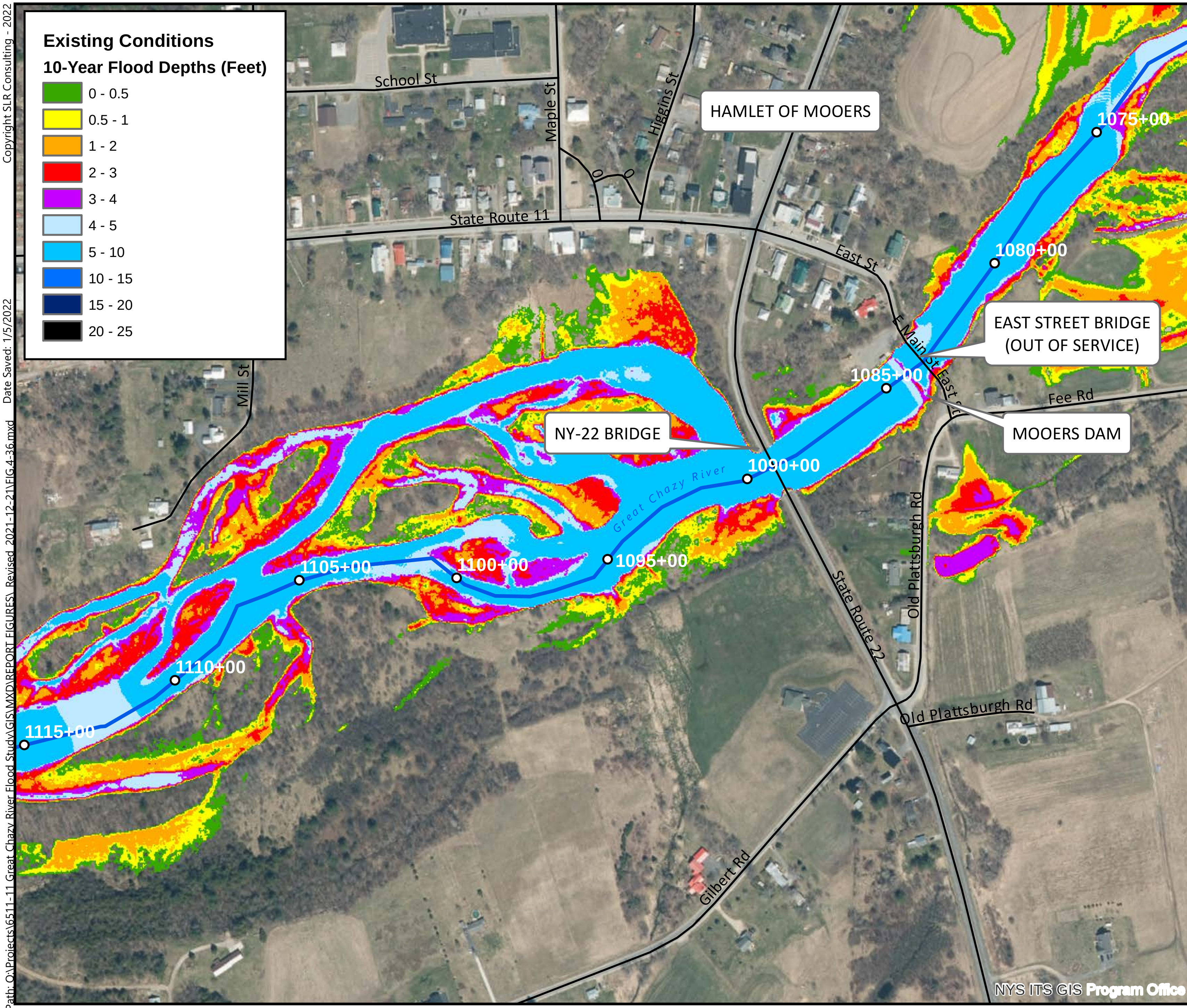
Figure 4-33: Mooers Dam. Fire suppression pump station is in background. Note seeps along concrete apron contact with bedrock in foreground.

The dam contributes to excess ice generation by creating roughly 2 acres of relatively stagnant impoundment, which can cause excess break-up ice accumulation upstream and affect the NY-22 and Tappin Road bridges, as shown in Figures 4-34 and 4-35.

Hydraulic modeling indicates that the Mooers dam contributes to additional flooding upstream, depicted in Figures 4-36 through 4-39. The structure also causes aggradation of alluvial material upstream of the NY-22 bridge and is an impediment to aquatic organism passage. Dam removal is therefore recommended. The hamlet operates a pump station on the river's left bank immediately upstream of this dam, which is used for fire suppression. A more conventional dry hydrant system, which does not require impoundment of the river, is recommended to replace the current configuration. A typical detail is shown in Figure 4-65 in Section 4.6. NYSDEC Region 5 Fisheries staff report that subsurface seepage conditions at the Whiteside Dam downstream in Perry Mills are permitting sea lamprey passage as far as the Mooers Dam. The Whiteside Dam is currently undergoing repairs to address this issue; proposed removal of the Mooers Dam should not proceed until these are completed and the intermediate reach is treated for lamprey.

Figure 4-34: Solid ice formed in the Mooers Dam impoundment reaches upstream past the NY-22 bridge. The crest of the dam and the bridge are in the center of the image, which is oriented to the east, looking downstream. Image is from March 2007 provided by Clinton County Department of Emergency Services.

Figure 4-35: Break-up ice jamming at the old Tappin Road bridge in March 2007. The bridge contraction, shallow wide bedrock channel, and solid ice formed behind the Mooers Dam downstream all contribute to ice accumulation at this crossing. View is to the south; flow is right to left in the image. Image is provided by Clinton County Department of Emergency Services.



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231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HRA #3 - EXISTING CONDITIONS 10-YEAR FLOOD
GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

SCALE 1 " = 400 '
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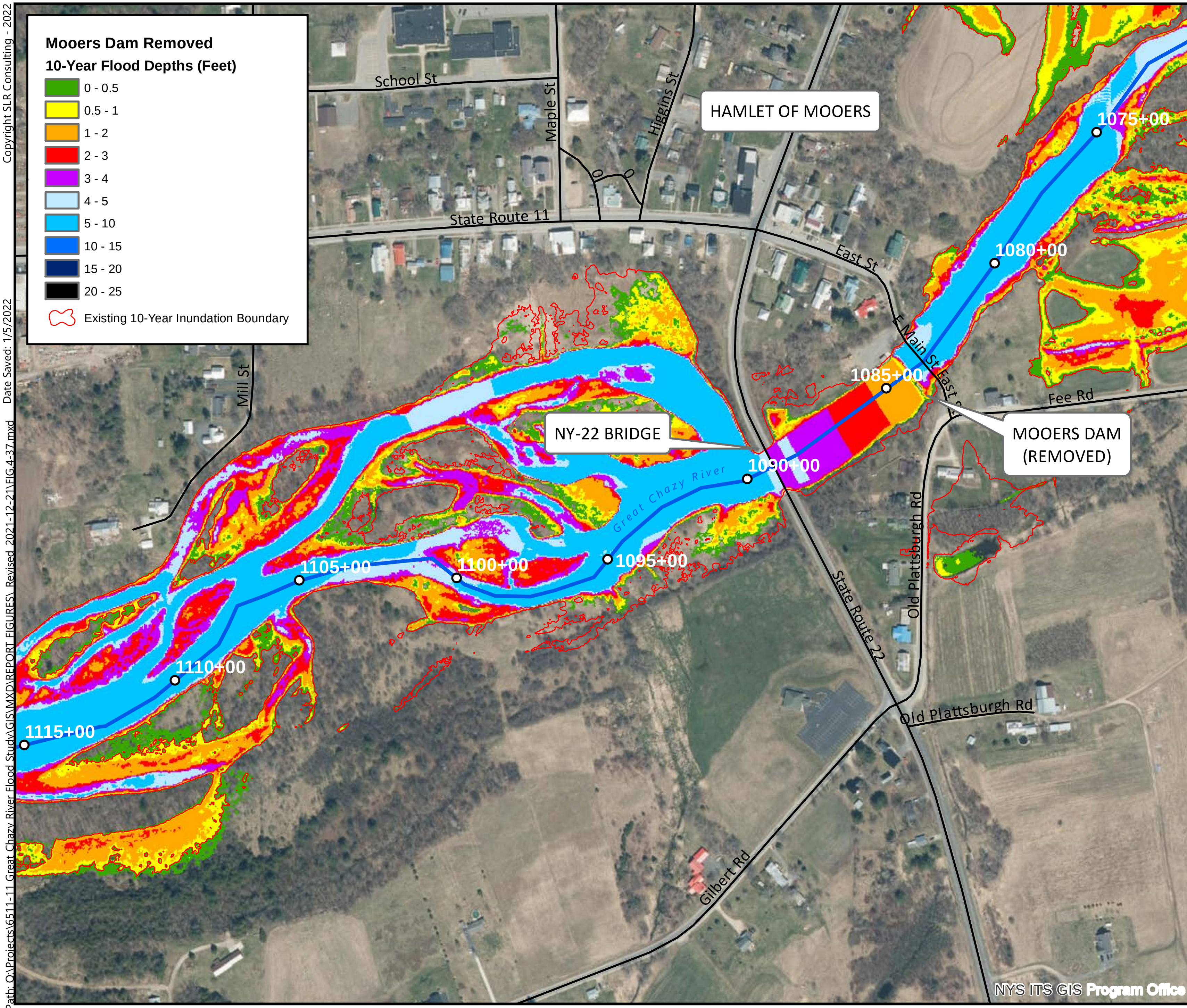
FIG. 4-36



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

HRA #3 - PROPOSED CONDITIONS 10-YEAR FLOOD
GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

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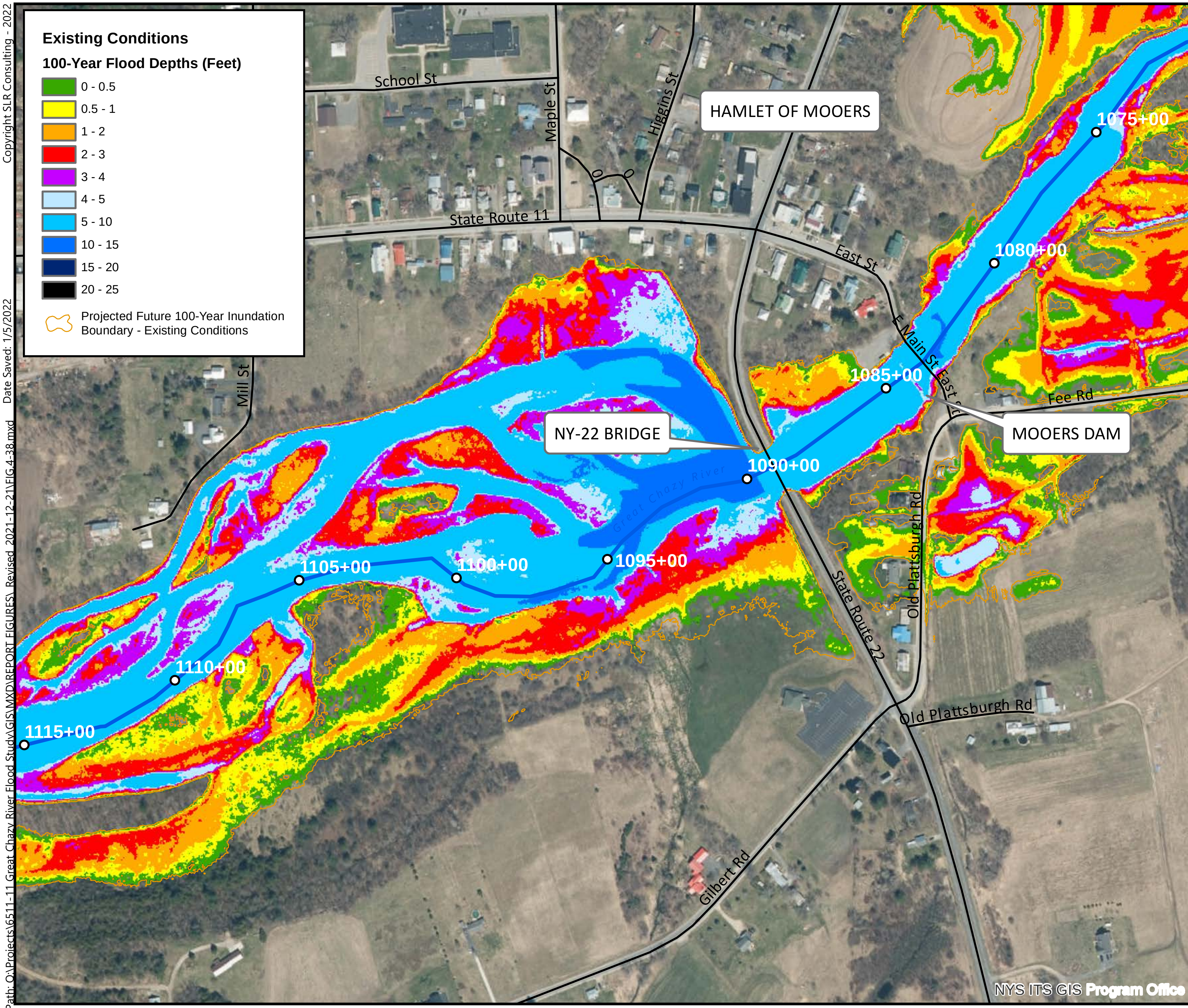
FIG. 4-37



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231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
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HRA #3 - EXISTING CONDITIONS 100-YEAR FLOOD

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY

SD119

CLINTON COUNTY
NEW YORK

SCALE 1 " = 400 '

DATE 1/5/2022

PROJ. NO. 16511.00011

FIG. 4-38

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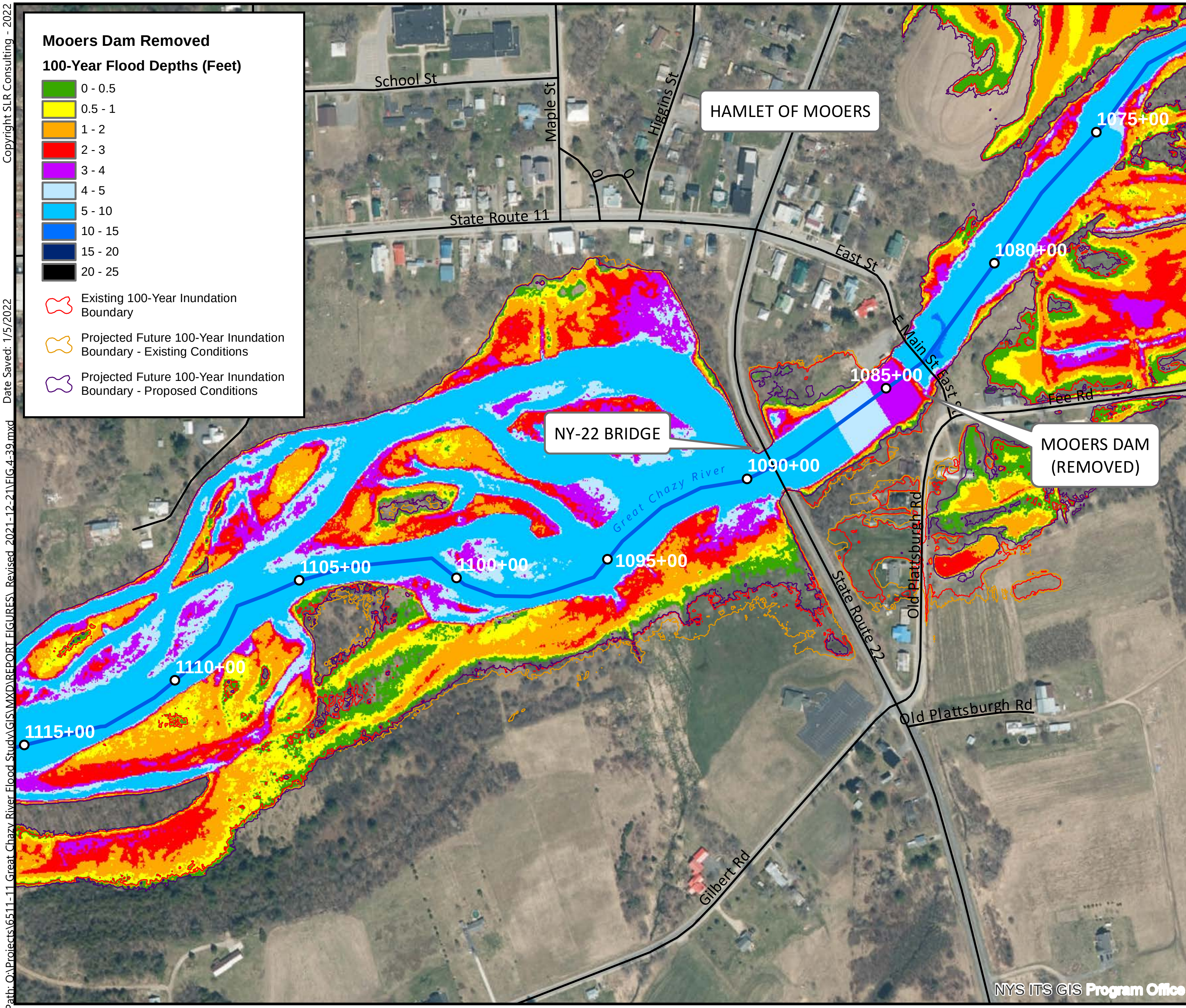

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SLR
231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HRA #3 - PROPOSED CONDITIONS 100-YEAR FLOOD

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

SCALE 1 " = 400 '

DATE 1/5/2022

PROJ. NO. 16511.00011

FIG. 4-39

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The Tappin Road bridge at STA 1155+00, a 110-foot two-span open-deck steel bridge built in 1958, was replaced with an approximately 125-foot single-span steel multibeam bridge in 2020 (NBI BIN: 3336260). Chronic ice jamming had been reported in this location; an example from March 2007 is shown in Figure 4-35. The Great Chazy River is characterized by a wide, shallow bedrock channel just upstream of this crossing, seen in Figures 4-40 and 4-41. A large, forested island is also present immediately upstream of the bridge; these natural features are prone to snagging ice, but this can be exacerbated by the Mooers Dam downstream as well as the valley constriction of the Tappin Road bridge approach embankments. These 10-foot to 15-foot-tall embankments extend into the river's 100-year floodplain by roughly 250 feet on the left (north) overbank and 200 feet on the right (south), restricting overbank relief of flood or ice flows. Minor backwaters develop behind the bridge in flood conditions, but this does not significantly affect developed areas upstream.

The Great Chazy River appears to be active within the alluvial materials present along this reach, but larger-scale riverine processes such as sediment transport are strongly influenced by bedrock, with valley slope set by intermittent exposures of sandstone and dolostone between the Adirondack mountains and Lake Champlain.

Figure 4-40: View looking upstream from the new Tappin Road bridge.

Figure 4-41: Upstream face of the new Tappin Road bridge; view is to the south. Flow is right to left in the image.

Upstream at STA 1201+00, the breached "Shefield Dam" is located adjacent to a lumber yard, just downstream of the intersection of US-11 and Duprey Road (NYSDEC: ID 217-0133; Federal ID: NY13634). Having been substantially breached or removed, the structure is categorized as Class D, Negligible or No Hazard dam. However, the left (eastern) portion of the concrete spillway remains, projecting about 75 feet into the channel and active floodplain, as seen in Figure 4-42. In addition to a potential debris and ice snagging site, this feature is currently instigating planform adjustment of the stream channel, with a large depositional bar forming downstream of the dam remnants and signs of erosion and failure of the opposite bank. This instability can propagate upstream and downstream, potentially threatening nearby homes, businesses, and roadways. Removal of the remaining portions of the Shefield Dam is recommended.

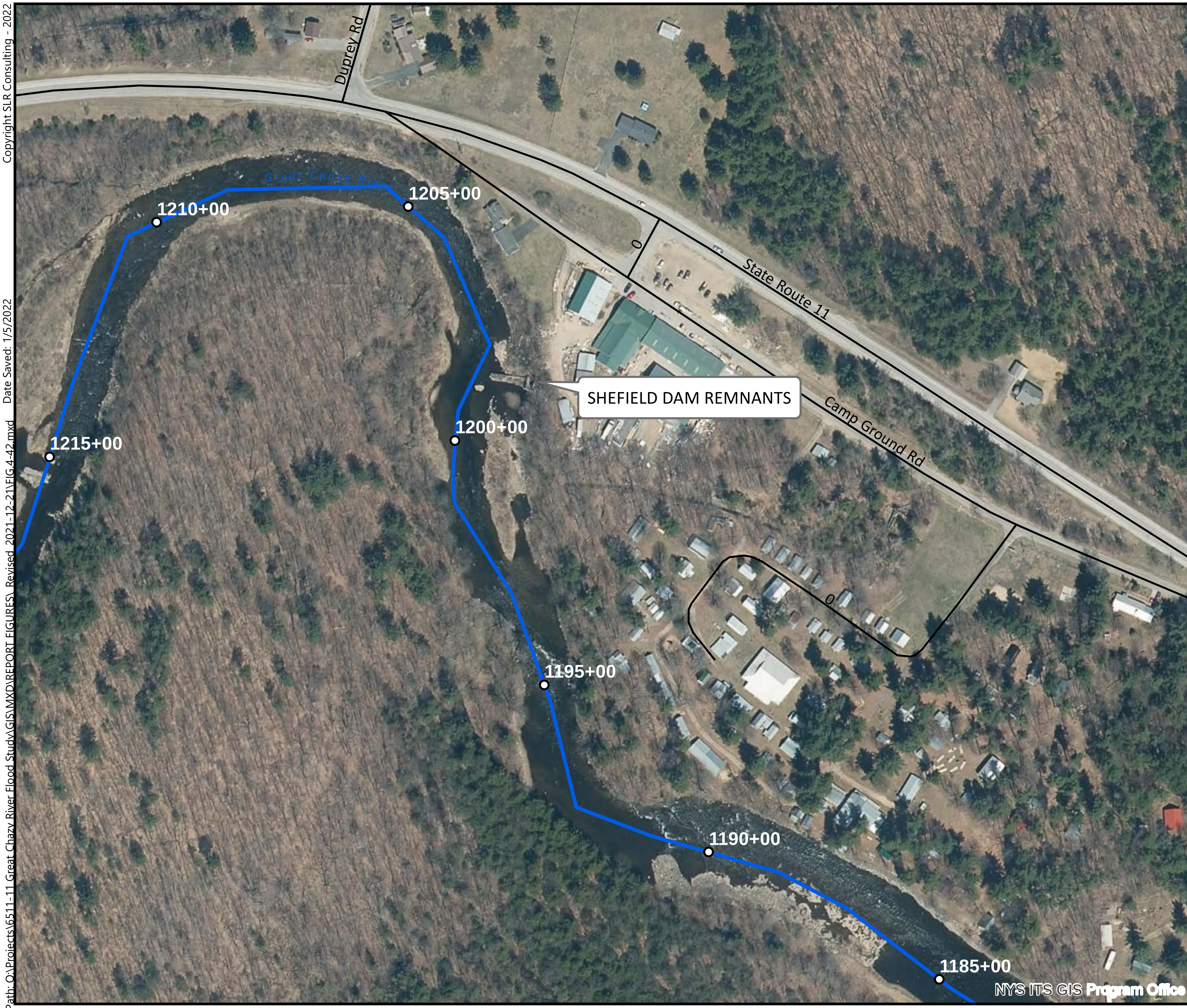
Potential relocations of flood-prone properties within HRA 3 unrelated to proposed flood and ice jam mitigation projects were also explored. Approximately 15 residential properties were identified as potentially needing to be relocated. These properties are not necessarily fully within a floodplain area – many parcels are only partially within a floodplain or adjacent to the edge of a floodplain.

A high-level conceptual relocation "Master Plan" of potential relocation areas for homes in HRA 3 is presented in Figure 4-43. 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.

Potential relocation sites were identified totaling 47 acres. Based on the analysis criteria utilized to calculate lot buildout, these parcels could provide relocation sites for all 15, or more, residential lots at a density generally consistent with the densities in the areas of each relocation site, utilizing existing cleared land area only. 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 15 residential uses and 0 nonresidential uses were identified as potentially needing to be relocated.

1) 1 parcel consisting of ~5.5 acres. Residential development potential – likely medium density (~ ½- to 1-acre minimum lot size). Access to Hemmingsford Road. With ½-acre lot size, eight or more residential lots, depending on density and site design, could likely be developed. The site is mostly cleared. The parcel is classified as vacant with improvements though there are no structures obvious from a review of aerial imagery.
2) 1 parcel consisting of ~19.5 acres. Residential development potential – likely medium density (~ ½- to 1-acre minimum lot size). Access to Maple Street and Route 11. With ½ acre lot size, 29 or more residential lots, depending on density and site design, could likely be developed. The site is mostly cleared. The parcel is classified as rural vacant > 10 acres.
3) 1 parcel consisting of ~22 acres. Residential development potential – likely medium density (~ ½- to 1-acre minimum lot size). Access to Route 11. With ½-acre lot size, 33 or more residential lots, depending on density and site design, could likely be developed. The site is mostly cleared. The parcel is classified as abandoned agriculture.



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231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
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HRA #3 - HAMLET OF MOOERS - SHEFIELD DAM
GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

SCALE 1 " = 250 '

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FIG. 4-42

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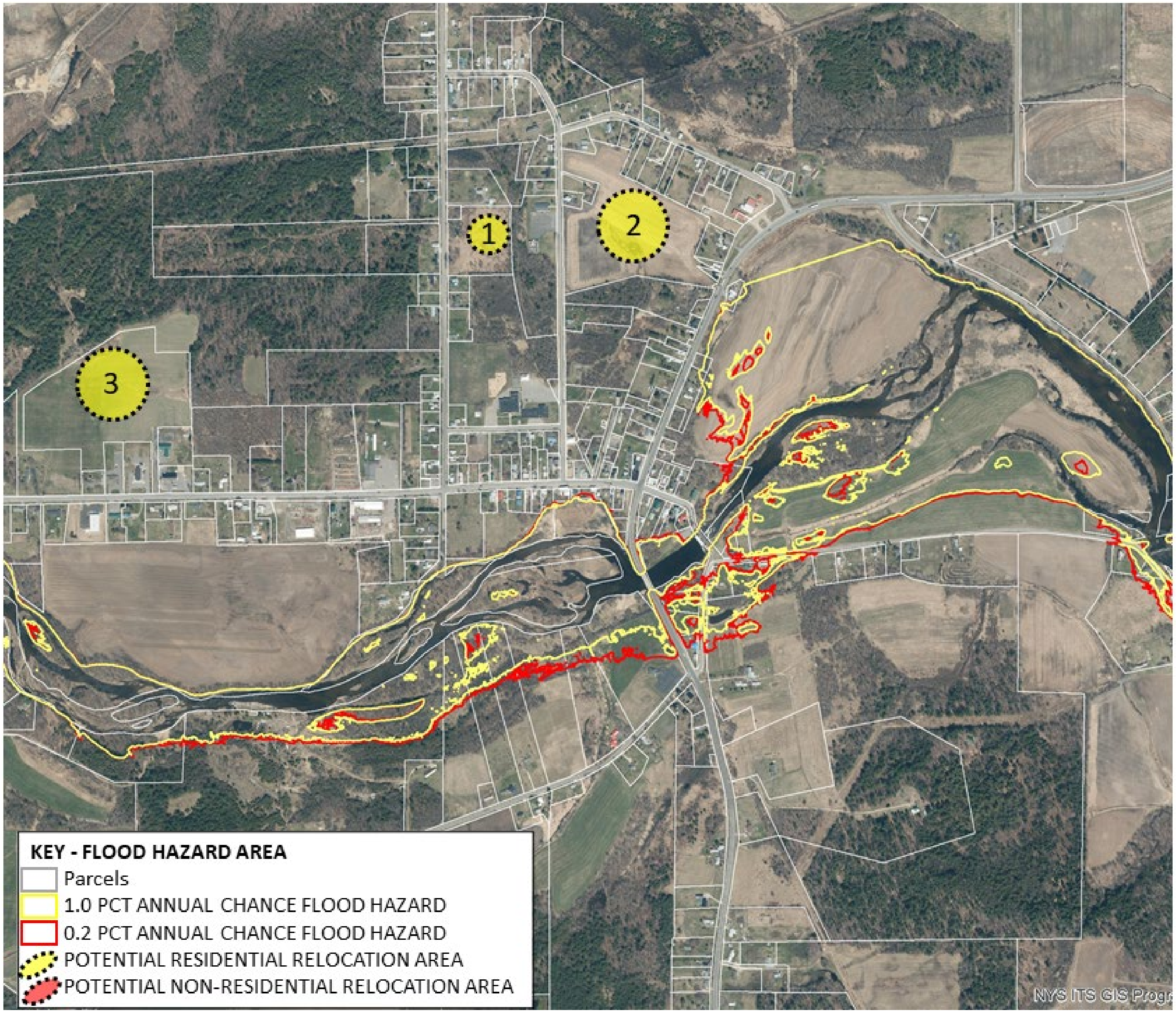

Figure 4-43 Conceptual redevelopment location mapping for HRA 3. See inset on previous page for descriptions.

The Clinton County Multi-Jurisdictional Hazard Mitigation Plan notes that the town of Mooers contains two repetitive loss properties. There are also 1,639 structures with the potential for loss. There are 12 structures in the SFHA (10 with property class code 200-Residential and 3 with property class code 300-Vacant Lands). The HMP notes the following mitigation projects related to flooding: perform routine cleaning of culverts in town and assess the need to upgrade or replace them.

The Town of Mooers Zoning Law includes eight zones: Residential Mixed Use, Commercial 1, Commercial 2, Open Space Conservation, Residential, Commercial, General Use, and Industrial. There is a section on green space buffers applying to certain land uses (two-family dwelling, multifamily dwelling; commercial and general uses; and industrial, trucking, and warehouse uses). There is also a section regarding land application, stockpiling/storage of biosolids, biosolid products, and/or human waste derived products, which shall not encroach into the 100-year floodplain.

mooersny.com/Departments/Zoning/Town_of_Mooers_Zoning_Law.CV01.pdf

4.4 HIGH RISK AREA 4 – HAMLET OF ALTONA

HRA 4 is located in the town and hamlet of Altona, with a downstream limit of the confluence of Bradford Brook just downstream of the crumbling LaSalle Powerhouse at STA 1485+00 and upstream to the McGregor Dam and Miner Lake at STA 1696+00, shown in Figures 4-44A and 4-44B. Along this reach, the county-owned Devil's Den Road culvert crossing of the Great Chazy River at STA 1628+00 was assessed, along with several dams and appurtenant structures associated with hydroelectric power generation in the early 20th century.

The hamlet of Altona is a small crossroads community along mostly the west side of the Great Chazy River between State Route 11 and Military Turnpike (Route 190). The residential community includes a few commercial uses as well as the Altona Correctional Facility. Flood-prone areas include residences, municipal park land, and vacant land. No critical facilities were identified in the floodplain.

The following land use types are found within HRA 4: Tax Classification Codes 100 - Agriculture, 200 - Residential, 300 – Vacant Land, 400 – Commercial, 500 – Recreation and Entertainment, 600 – Community Services, and 900 – Wild, Forested, Conservation Lands and Public Parks.

The Devil's Den Road crossing of the Great Chazy River at STA 1628+00, pictured in Figures 4-44 and 4-45, consists of a twin-barreled three-sided cast-in-place concrete box culvert founded upon the bedrock ledge that forms the channel bed along this reach (NBI BIN: 3336320). The hydraulic opening of each barrel measures about 18.5 feet wide and 13.2 feet tall, and the conduits are 87 feet long. This structure is hydraulically undersized, is prone to snagging debris, and was the site of two fatalities during Tropical Storm Irene in 2011, when the 12 to 15 feet of cover fill on top of the culvert washed out. A similar washout was reported during a flood event in 1996. Note that the LaSell Dam, which has since been removed, was in place just 250 feet upstream when these washouts occurred and likely had a significant influence on hydrodynamics during these floods.

Hydraulic modeling indicates that this culvert is capable of conveying flood flows under clear water conditions although it generates more than 2 feet of additional upstream flood depths in the 10-year flood and over 3 feet of backwater in the 100-year flood. The 500-year flood generates 4.5 feet of additional upstream flooding, which exceeds the culvert's ceiling elevation by more than 3 feet.

Partial occlusion of the culvert was modeled to represent debris-jamming conditions. Blockage of half of the hydraulic opening results in over 12 feet of backwater flooding in the 10-year discharge and almost 20 feet of additional upstream flooding in the 100-year event, which results in Devil's Den Road overtopping by more than 2 feet. High-velocity supercritical overtopping flow can rapidly erode roadway embankments.

This crossing is sited in a relatively confined reach of the Great Chazy River, with bedrock comprising the majority of the stream bed and banks. Removing the encroaching portions of the existing approach embankments to match the upstream channel dimensions and replacing the culvert with a single-span bridge would alleviate the current flow constriction at this location, dramatically reducing the potential for debris and ice jamming here that can cause roadway overtopping and washout under the existing configuration.

Figure 4-44: Devil's Den Road culvert crossing of the Great Chazy River. View is looking upstream from the culvert.

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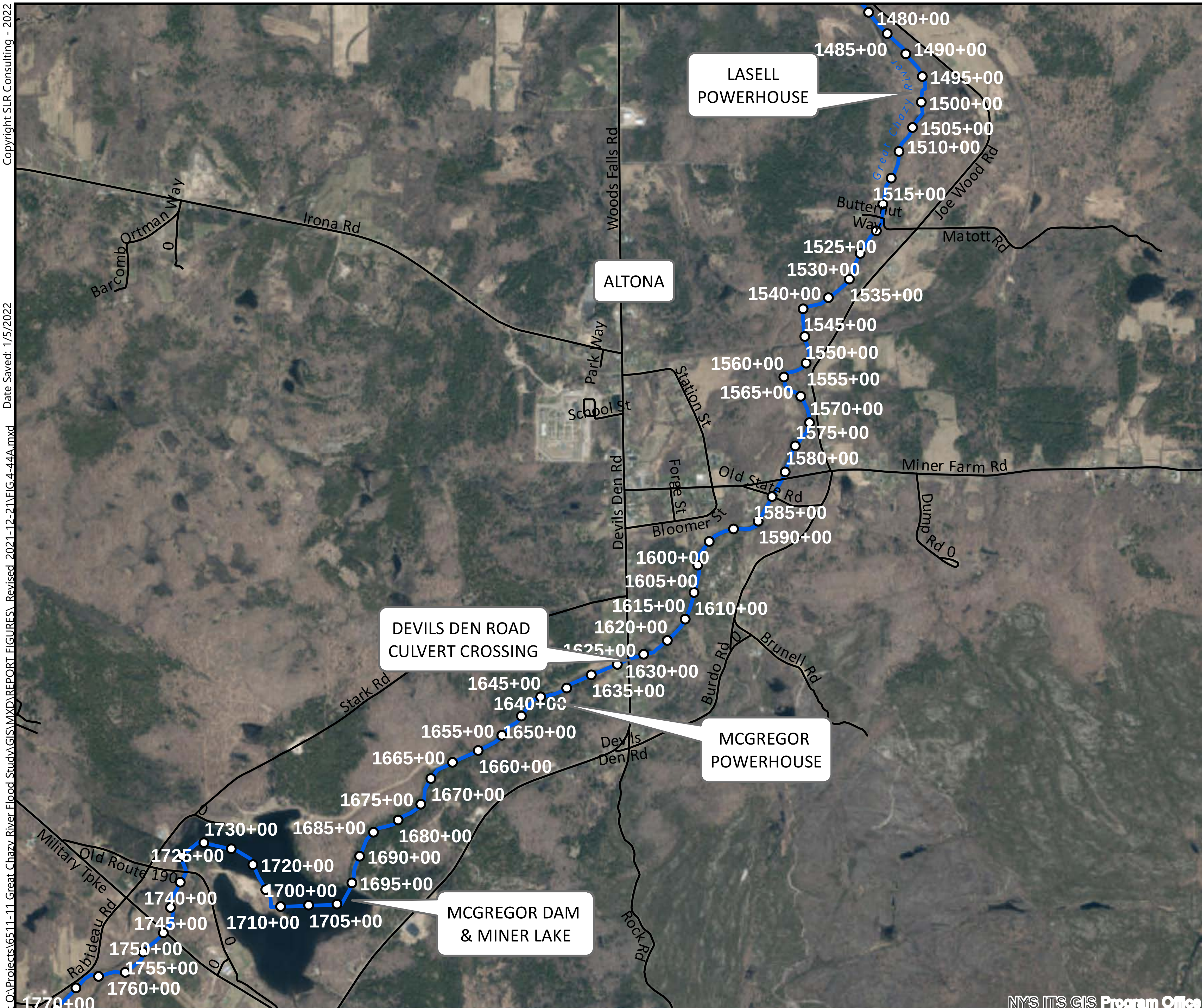

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SLR

231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HIGH RISK AREA #4 - TOWN OF ALTONA

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

SCALE 1 " = 2,400 '

DATE 1/5/2022

PROJ. NO. 16511.00011

FIG. 4-44A

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

HIGH RISK AREA #4 - TOWN OF ALTONA

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY

SD119

CLINTON COUNTY
NEW YORK

SCALE 1 " = 250 '

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FIG. 4-44B

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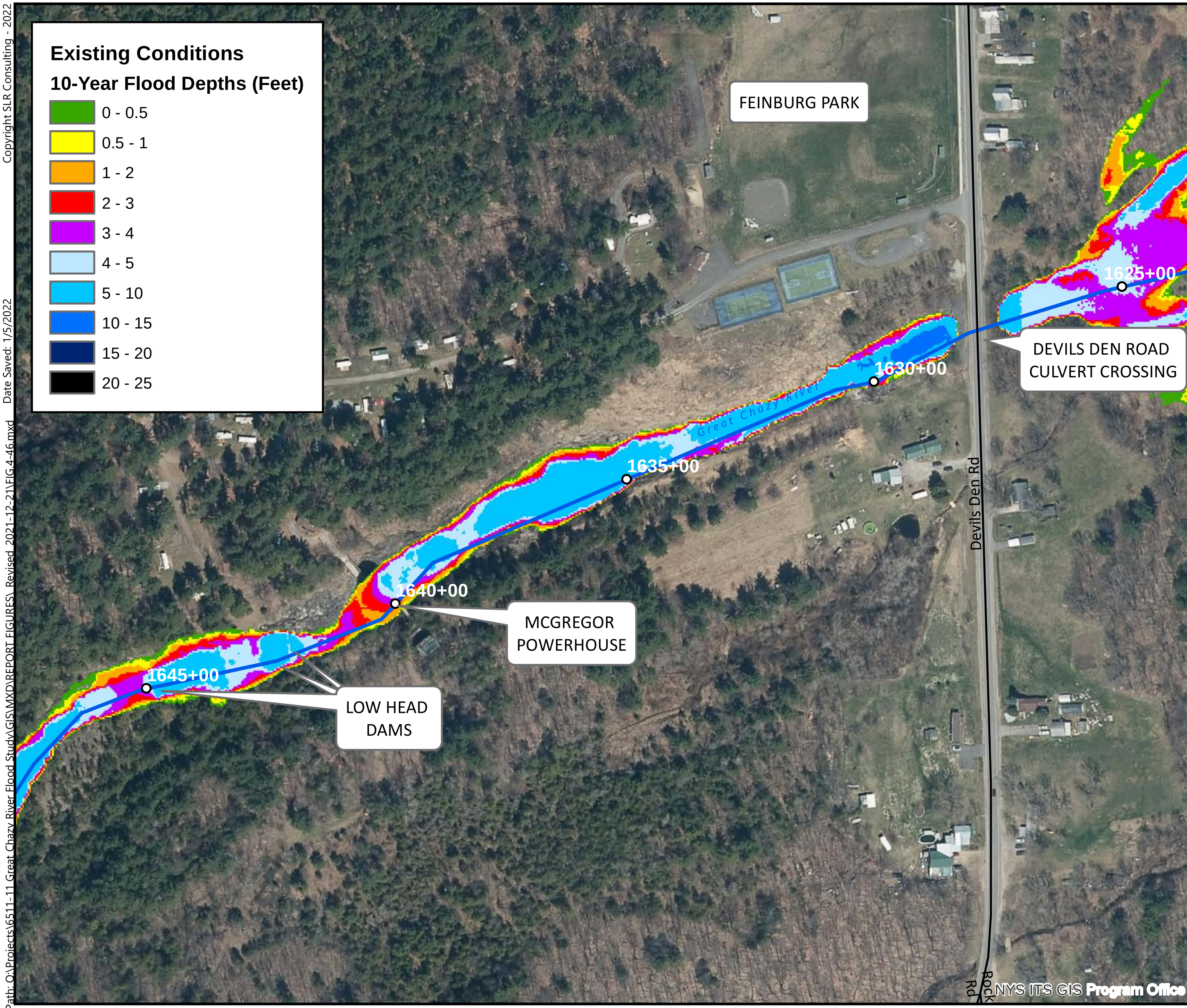
Figure 4-45: Devil's Den Road culvert crossing of the Great Chazy River. View is looking downstream from upstream right bank.

Because the existing roadway crest is about 30 feet higher than the streambed and the modeled 500-year flood only flows about 12 feet deep with the culvert constriction removed, the necessary length of the replacement span may vary depending on the substructure design and extent of practical approach roadway regrading. For example, a vertically abutted bridge may only need to be 90 feet long, but relatively tall vertical abutments add cost. Sloped abutments are less costly but would require a proportionally increased span. Even with a thick superstructure, considerable freeboard would be available if the elevation of the approach roadway and replacement bridge deck remained as in the existing profile, so reducing the road crest elevation is possible and allows for some flexibility in design. The upshot is that with stream banks through the replacement bridge graded to match the upstream channel dimensions up to a height of about 15 feet above the streambed elevation such that the approach embankments and abutments do not project into the floodplain, a bridge with a minimum rise of this same height above the bed, at minimum spanning the resulting distance of 90 feet, is modeled as passing current and projected future floods consistent with applicable NYSDOT stream crossing standards.

Within the vicinity of the Devil's Den Road crossing of the Great Chazy River, six dams currently or formerly impounded the Great Chazy River, associated with a large hydroelectric project constructed in the early 1920s by W.H. Miner. This included several miles of penstocks and two powerhouses, one of which was constructed directly in the river channel and should be considered as a seventh dam in this series.

The farthest upstream of this series of dams is the McGregor Dam at STA 1696+00 (NYSDEC ID: 217-3627; Federal ID: NY00614), which creates Miner Lake and originally supplied water to the McGregor Powerhouse at STA 1640+00, a little over a mile downstream. This 37-foot-tall, Class C High Hazard concrete slab-and-buttress dam was first built by W.H. Miner in 1922 and was rebuilt in 1968. It is currently owned by NYSDEC. It has undergone substantial repairs over the past decade following damage in 2011 related to Tropical Storm Irene. According to the individual incident reporting in the Association of State Dam Safety Officials database, peak lake stage was 4 feet above the tertiary spillway during this flood. Damages included erosion of between 6 inches and 12 feet of sandstone bedrock at the base of the spillway, with additional minor scour beneath several of the concrete splash aprons (Association of State Dam Safety Officials [ASDSO] Incident ID: NY00614-1318). The lake is used for recreation, with an engineering assessment completed in 2018; it was last inspected in 2019, and an emergency action plan was completed the same year.

Just upstream of the McGregor Powerhouse, a series of three low-head dams impound the Great Chazy River at STA 1642+10, STA 1642+50, and STA 1644+80. These are not included in the NYSDEC dam inventory (February 2021 Revision), and it is recommended that they be assessed and inspected for inclusion. Between these dams and the powerhouse, several massive concrete piers are situated directly in the stream channel and its immediate overbanks, shown in Figure 4-52; these supported the penstock from Miner Lake before the steel pipe was scrapped in the early 1960s. It is recommended that these obstructions to flow and ice and debris passage be removed. The McGregor Powerhouse is located directly in the river channel at STA 1640+00, as shown in Figure 4-53. Figure 4-54 shows how low flows contract to a narrow chute along the right side of the building, the upstream corner of which is eroding away as a result. Three spillways underneath the building convey high flows. Due to the building's location and construction, classification of the structure as a dam in the NYSDEC inventory is apparently appropriate, and an assessment by NYSDEC for this purpose is recommended.



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

HRA #4 - DEVILS DEN ROAD - 10-YEAR FLOOD
GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

SCALE 1 " = 250 '
DATE 1/5/2022
PROJ. NO. 16511.00011

FIG. 4-46

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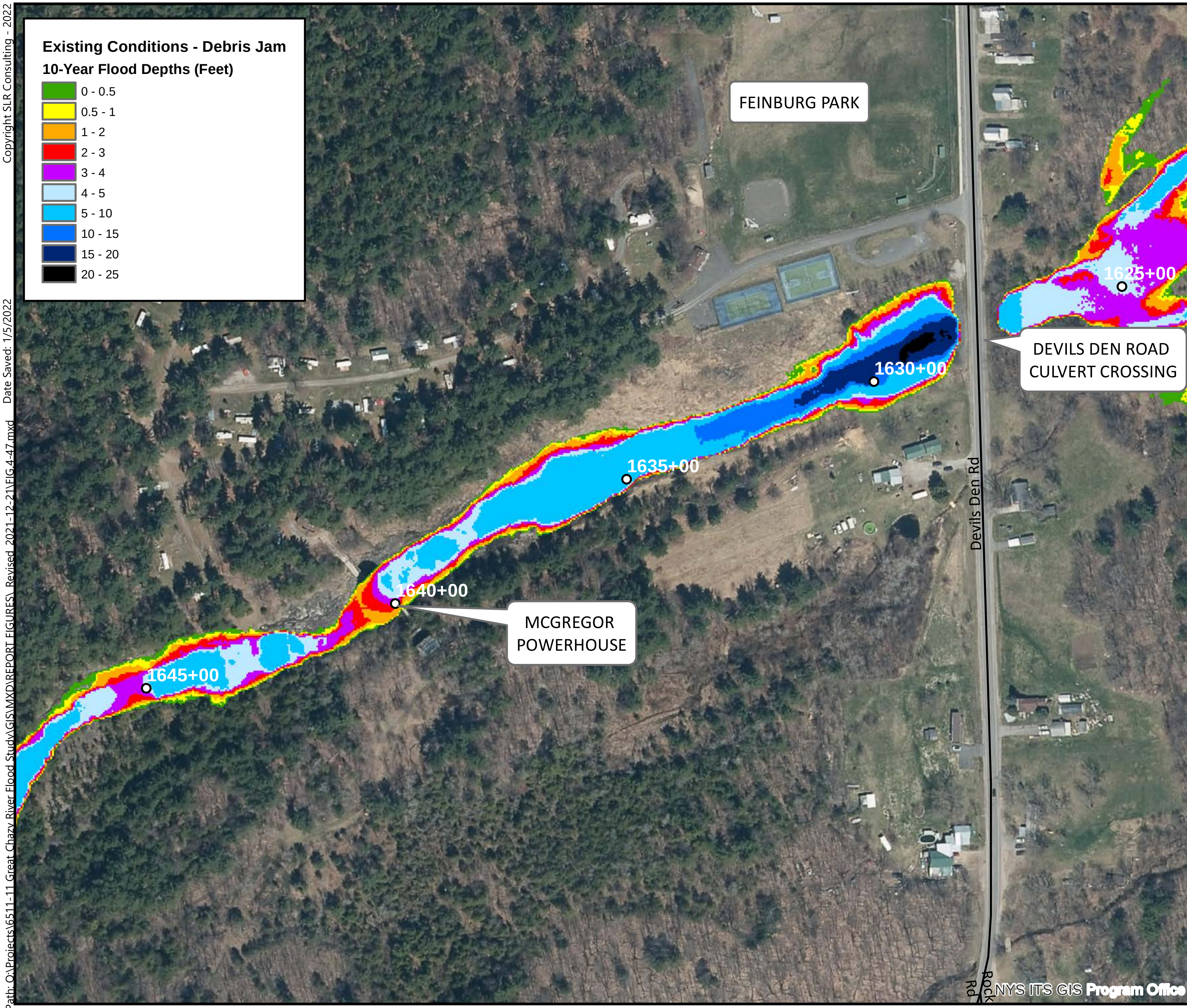

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SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HRA #4 - DEVILS DEN ROAD - DEBRIS JAM - 10-YEAR FLOOD
GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

SCALE 1 " = 250 '

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FIG. 4-47

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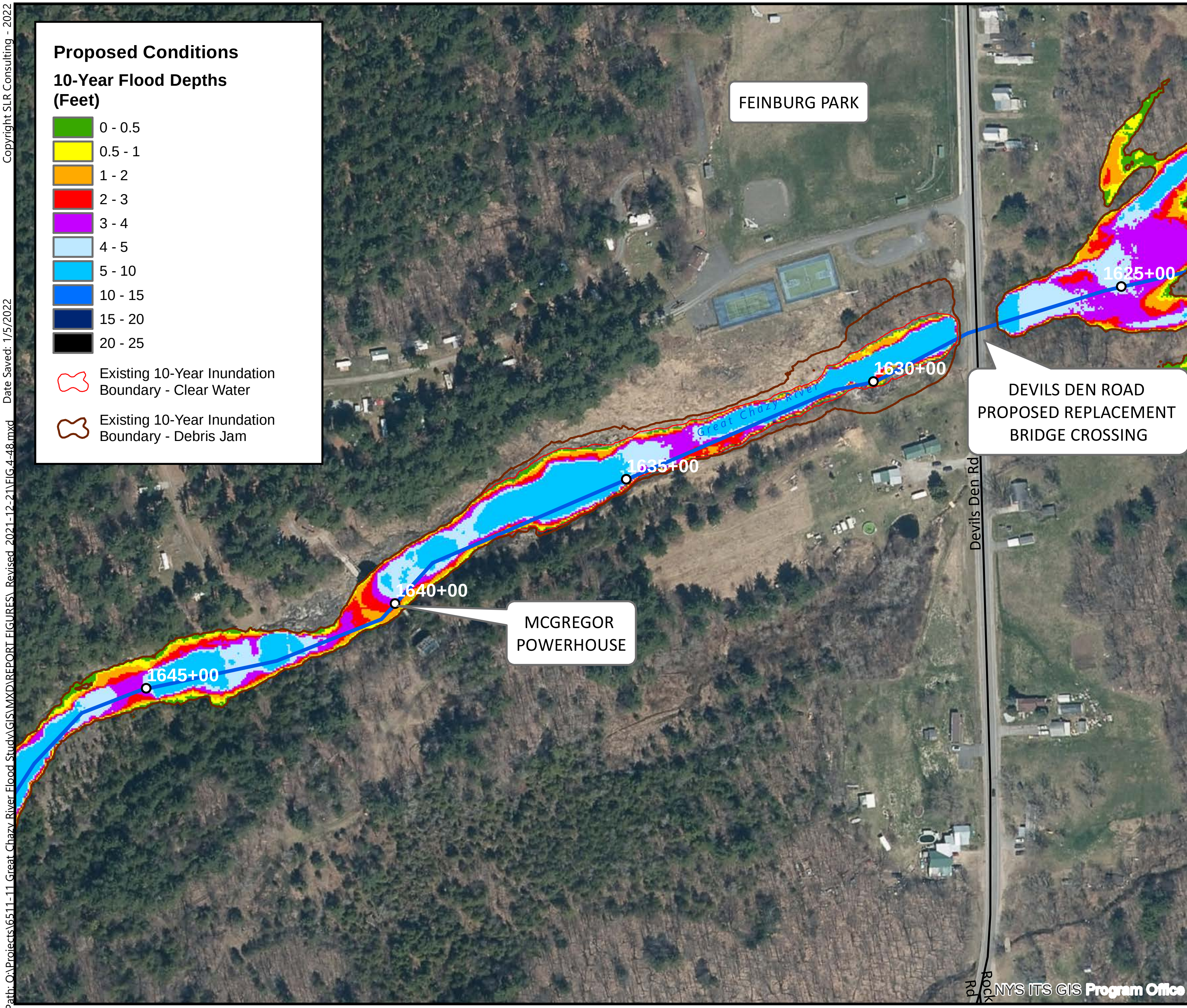

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231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HRA #4 - PROPOSED CONDITIONS - 10-YEAR FLOOD

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY

SD119

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NEW YORK

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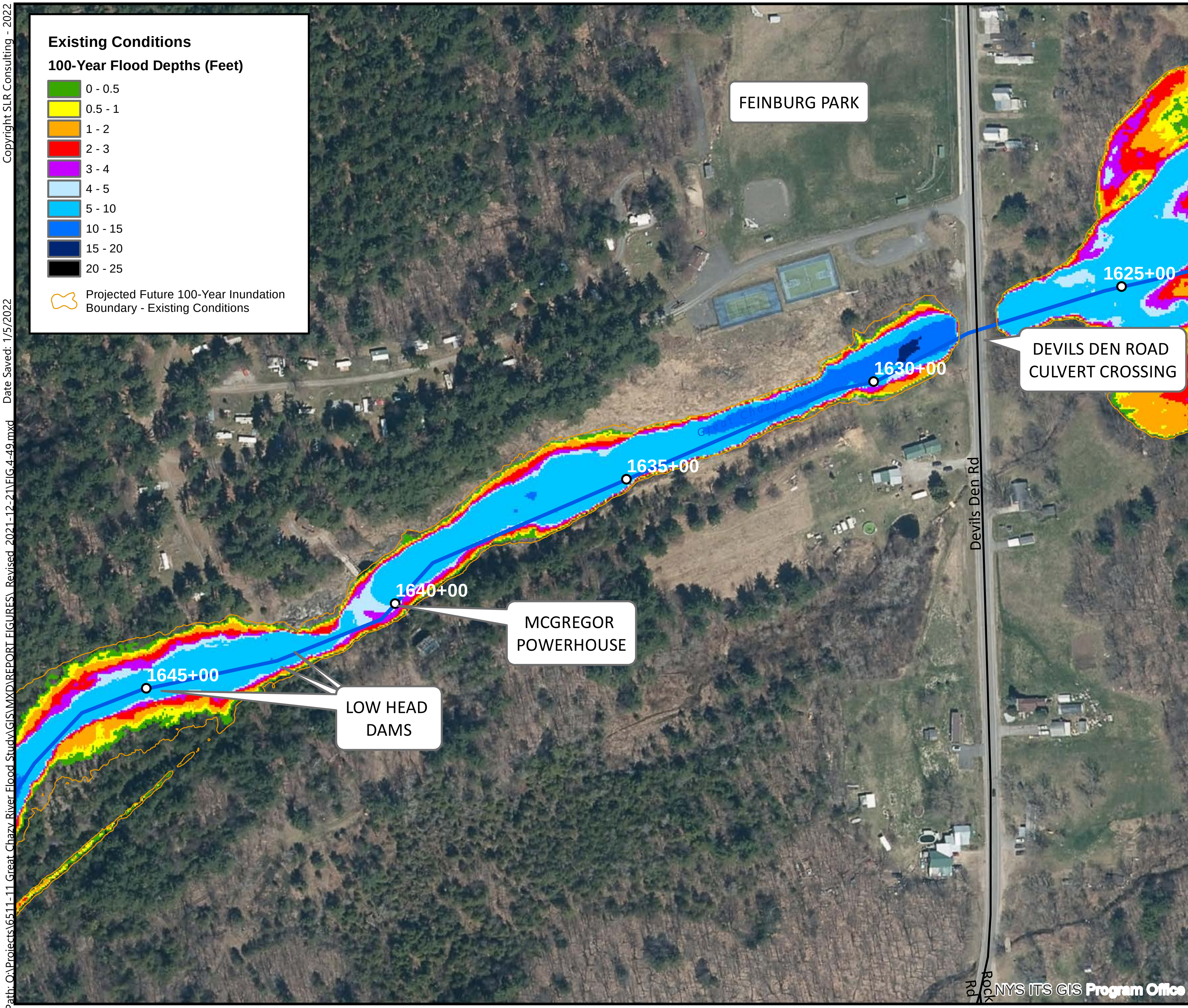
FIG. 4-48



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231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HRA #4 - DEVILS DEN ROAD - 100-YEAR FLOOD

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY

SD119

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NEW YORK

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FIG. 4-49

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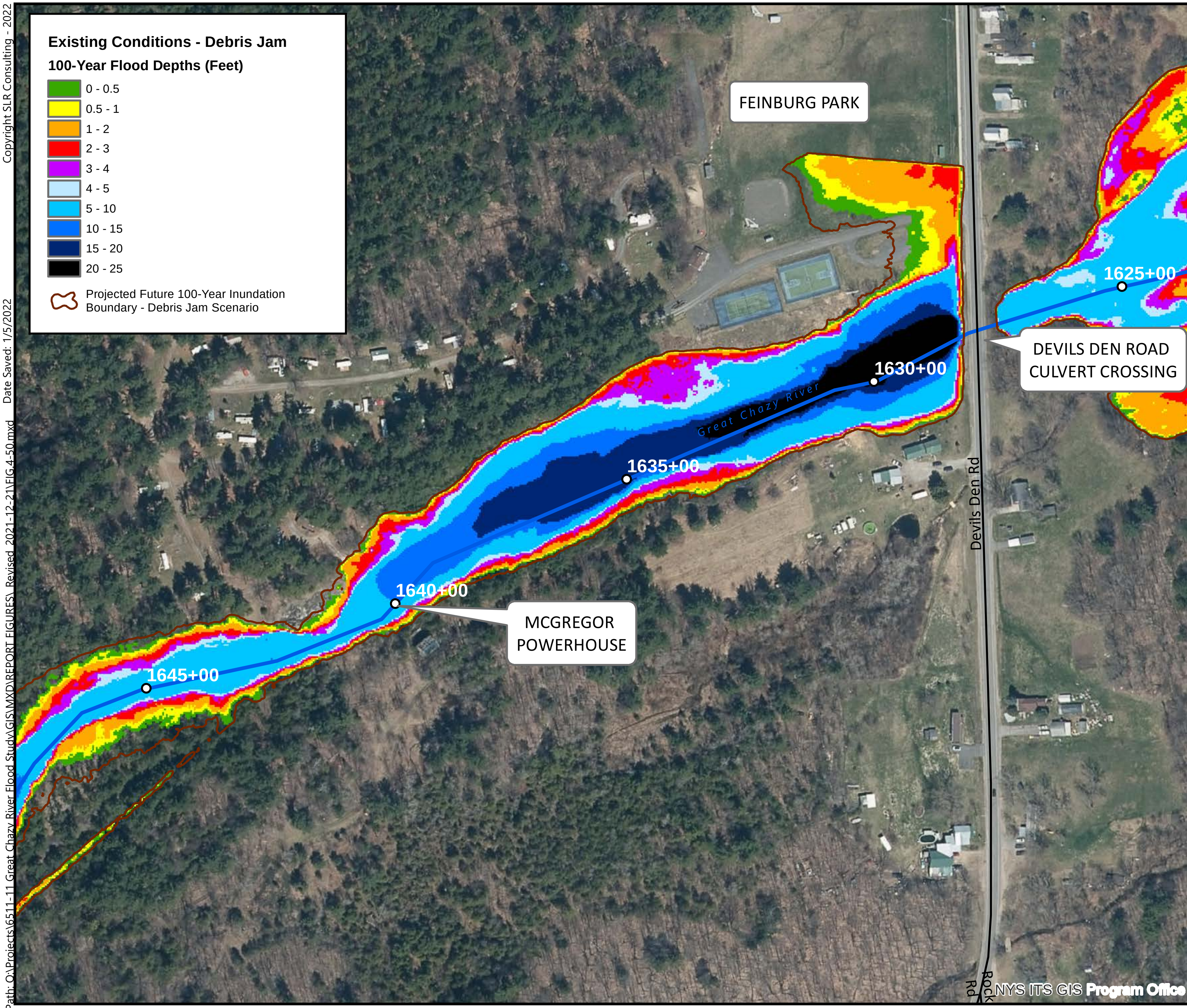

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SLR
231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HRA #4 - DEVILS DEN ROAD - DEBRIS JAM - 100-YEAR FLOOD

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY

SD119

CLINTON COUNTY
NEW YORK

SCALE 1 " = 250 '

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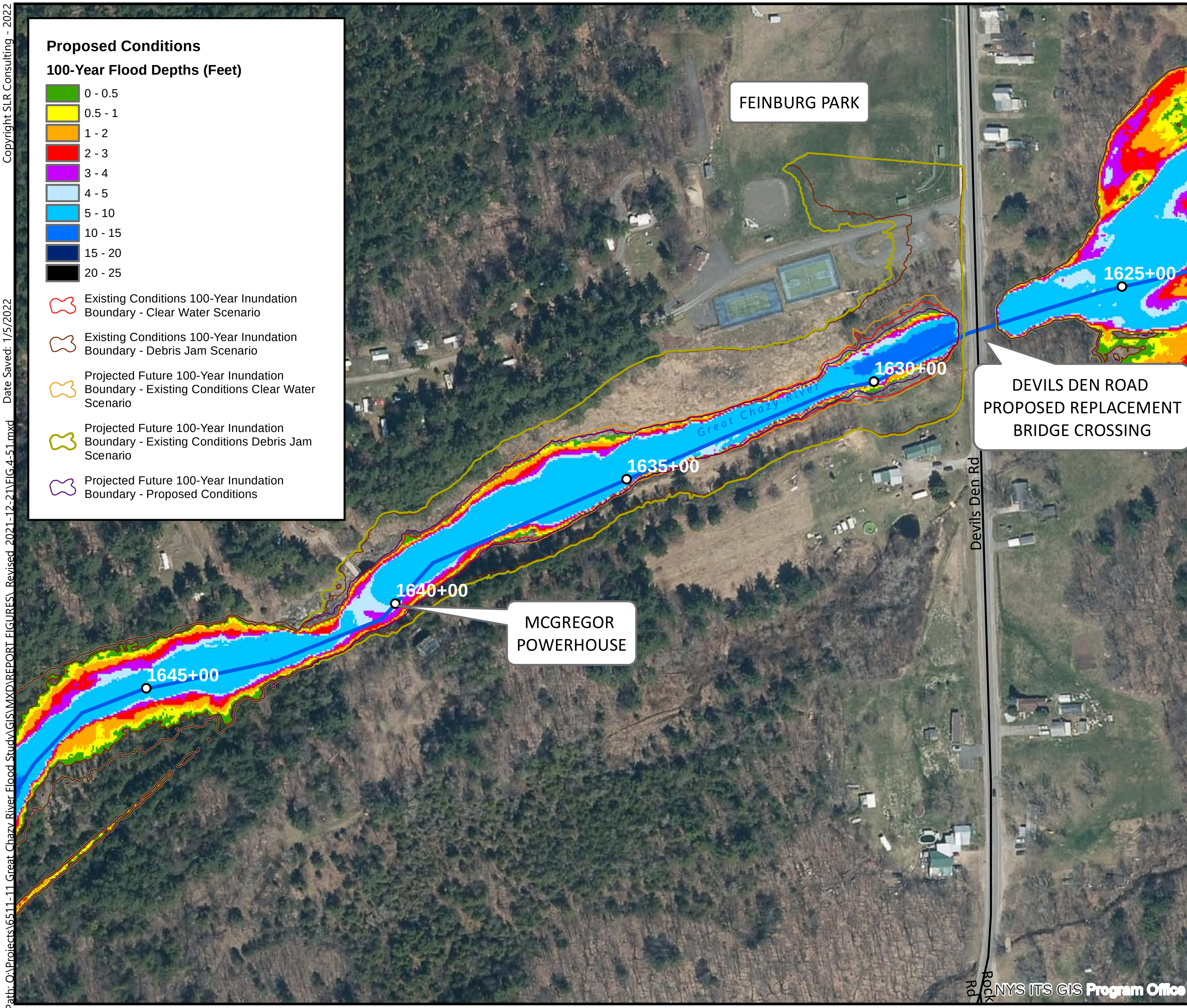
PROJ. NO. 16511.00011

FIG. 4-50



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231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HRA #4 - PROPOSED CONDITIONS - 100-YEAR FLOOD

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY

SD119

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NEW YORK

SCALE 1 " = 250 '

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FIG. 4-51

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Figure 4-52: Concrete piers that formerly carried penstocks from McGregor Dam to McGregor Powerhouse were constructed in the river channel. Low-head dam is visible in background on left side of image.

Figure 4-53: McGregor Powerhouse, constructed across the Great Chazy River. Normal flows pass around the right side of the building (left side in image).

Figure 4-54: Upstream corner of McGregor Powerhouse. Note erosion of concrete and snagged woody debris.

The McGregor Powerhouse discharged almost directly into the impoundment of the former LaSell ("LaSalle") Dam, located at STA 1630+50. This 35-foot-tall dam was completed in 1923 and served as the headworks for the LaSell Powerhouse downstream. Having been removed following damage sustained during Tropical Storm Irene in 2011, this dam is currently rated as a Class D, Negligible or No Hazard dam (NYSDEC ID: 217-0177; Federal ID: NY01464). The structure was already in a far-gone state of disrepair following abandonment of the hydroelectric project in the mid 20th century, and one of the slabs in the main section of the Ambursen-style flat slab-and-buttress dam had breached prior to the 2011 flood. The LaSell Dam is pictured in Figures 4-63 and 4-64, along with important considerations regarding abandoned or neglected structural dams of this vintage, discussed in Section 4.6 of this report.

A penstock carried water from the LaSell Dam outlet works about another 3 miles downstream to the now-dilapidated LaSell Powerhouse on the left overbank at STA 1503+00, which can be seen in Figure 4-55. The penstock crossed the river four times (approximately STA 1526+00, STA 1565+50, STA 1593+50 and STA 1609+00), with large concrete piers in the channel and immediate overbanks; this penstock's steel was also scrapped in the 1960s. Removing these obstructive concrete remnants is recommended as well. A dam is located at the LaSell Powerhouse site at STA 1497+00, which is not in the NYSDEC's inventory. The impoundment has filled with sediment, which appears to have caused an avulsion of the Great Chazy River's primary flow path into Bradford Brook to the north and east, which runs along CR-15/Joe Wood Road and joins the Great Chazy downstream of this derelict dam and the LaSell Powerhouse tailraces. This can be seen in the aerial imagery shown in Figure 4-55. Inclusion of this dam in the NYSDEC inventory is recommended. Removal of this dam and restoration of the Great Chazy River channel through the impoundment and old tailraces, away from the roadway, are recommended.

The central pier of an abandoned bridge crossing is located at STA 1551+00. It is recommended that this and all other remaining substructural elements of the crossing be removed to permit unrestricted passage of flood flows, debris, and ice.

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SUITE 102
NEW PALTZ, NY 12561
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HRA #4 - AVULSION AT LASELL POWERHOUSE
GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

SCALE 1 " = 400 '
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FIG. 4-55

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Potential relocations of flood-prone properties within HRA 4 unrelated to proposed flood and ice jam mitigation recommendations were also explored. Approximately 20 residential and/or mixed-use properties were identified as potentially needing to be relocated. These properties are not necessarily fully within a floodplain area – many parcels are only partially within a floodplain or adjacent to the edge of a floodplain.

A high-level conceptual relocation "Master Plan" of potential relocation areas for homes in HRA 4 is presented in Figure 4-56. 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 20 residential properties were identified as potentially needing to be relocated. Three potential relocation sites were identified totaling 224 acres. Based on the analysis criteria utilized to calculate lot buildout, these parcels could provide relocation sites for significantly more than the 20 identified relocation parcels, a density generally consistent with the densities in the areas of each relocation site, utilizing existing cleared land area only. 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 20 residential uses and 0 non-residential uses were identified as potentially needing to be relocated.

1) 1 parcel consisting of ~166 acres. Residential development potential – likely low density (1.5 to 2-acre minimum lot size). Access to Miner Farm Road and Joe Wood Road (though this access is adjacent to floodplain). Thirty-seven or more residential lots on the cleared portion of the site only, depending on density and site design, could likely be developed. Significantly more could be developed if the site was cleared further. The parcel is approximately 1/3 cleared. The parcel is classified rural residential, and there is an existing home at the southeast corner of the property but well away from most of the existing cleared land.
2) 1 parcel consisting of ~2 acres. Residential development potential – likely medium density (~ ½-acre minimum lot size). Access to Miner Farm Road and Station Street. Three or more residential lots, depending on density and site design, could likely be developed. The parcel is mostly cleared. The parcel is classified as rural vacant < 10 acres.
3) 1 parcel consisting of ~56 acres. Residential development potential – likely medium density (~ ½-acre minimum lot size). Access to Station Street. Twenty-five or more residential lots on the cleared portion of the site, depending on density and site design, could likely be developed. Significantly more could be developed if the site was cleared further though the floodplain encroaches on the far back portion of the lot and should be avoided (the development portion is well beyond the floodplain boundary). The parcel is approximately 1/3 cleared. The parcel is classified abandoned agriculture.

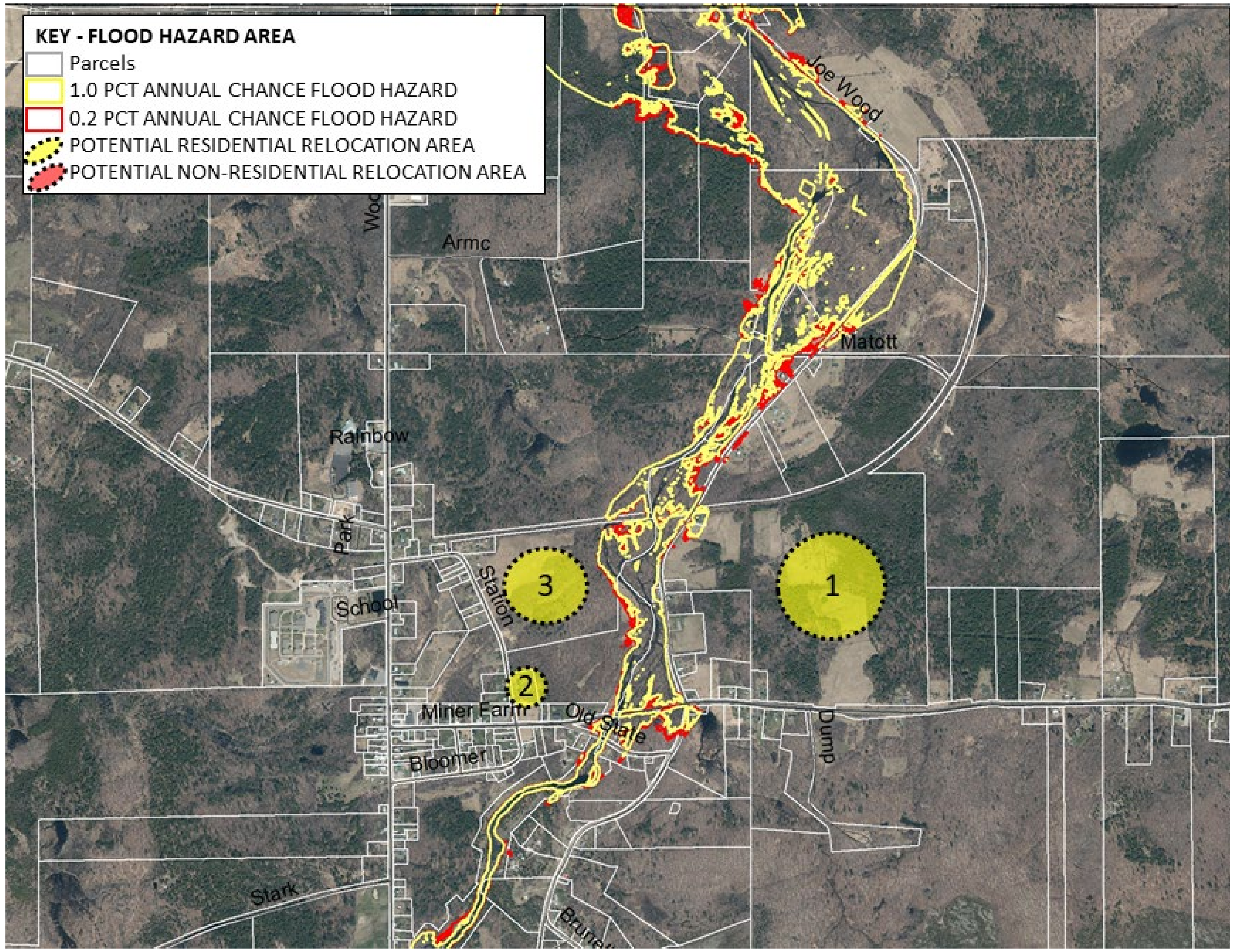

Figure 4-56: Conceptual relocation map for hamlet of Altona. See inset on previous page for descriptions.

The Clinton County Multi-Jurisdictional Hazard Mitigation Plan notes that the FIRM panels are being updated, and the town has a Comprehensive Plan from the 1990s and a Greenspace Plan. The Zoning Ordinance was available online and reviewed below. The town has had seven flood insurance claims. Altona has no repetitive loss properties. There are 1,208 structures within the potential loss category. There are eight structures in the SFHA (six with property class code 200-Residential and two with property class code 400-Commecial). The HMP notes the following mitigation project related to flooding: upsize the bridge on Devil's Den Road in 2011 and replacement of two undersized culverts with box culverts in Barnabee Road.

The Town Zoning Law includes three zones: Rural Use, Industrial/Commercial, and Hamlet. The majority of the land uses are permitted by special permit. Cluster development is also permitted by special permit. Green space buffers are required for commercial and industrial uses. Within the special permit regulations, there is a section about drainage and erosion control that 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…waterways." The cluster development section for three or more residential structures or a subdivision of three or more lots has a net buildable site area that subtracts out wetlands, flood hazard area, steep slopes exceeding 15 percent, rock outcrops, and other unbuildable lands.

SKM_C300i21101313220 (townaltona.com)

The town of Altona has wild forest and resource management lands within the Adirondack Park according to the Adirondack Park State Land Master Plan map.

4.5 HIGH RISK AREA 5 – ELLENBURG CENTER AND ELLENBURG DEPOT

HRA 5 is located along the North Branch of the Great Chazy River, extending from the McGregor Dam at STA 635+00 to the Ranch Side Campground at STA 860+00, shown in Figure 4-57. Hydraulic modeling for this watercourse is not available. Flash flooding occurred along this reach of the North Branch Great Chazy River in summer 2010, when 5.6 inches of rain reportedly fell on the upper Great Chazy watershed over 2 days. Flooding in spring 2018 also had devastating consequences along the headwater reaches of the Great Chazy River and its tributaries, as can be seen in the linked video: https://www.pressrepublican.com/ellenburg-flood/video_87e205a0-73f5-5771-983d-c532abfeacac.html.
Sections of the Ranch Side Campground along the North Branch of the Great Chazy River suffered considerable damage and closure of several roadways, including NY-190 in four locations.

The McGregor Dam is located about 120 feet upstream of the Canaan Road crossing of the North Branch of the Great Chazy River at STA 635+00 (NYSDEC ID: 199-0233; Federal ID: NY13282; 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, which is discussed in Section 4.3). This concrete and masonry gravity dam, built in 1919, suffered damages due to overtopping in a flood in August 2010. Damage included washout of the left earthen closure embankment and scour and undermining of the left abutment and training wall, as depicted in Figures 4-61 and 4-62 in Section 4.6 of this report. Overtopping of this section of the dam is indicative of inadequate spillway performance, which poses a hazard to life safety, property, and infrastructure in future flood events. The dam was last inspected in 2005, with an Emergency Action Plan completed in 2006. The dam's listed purpose is irrigation; removal of the dam and replacement of any necessary withdrawal appurtenances with dry hydrant systems that do not require impoundment of the river are recommended.

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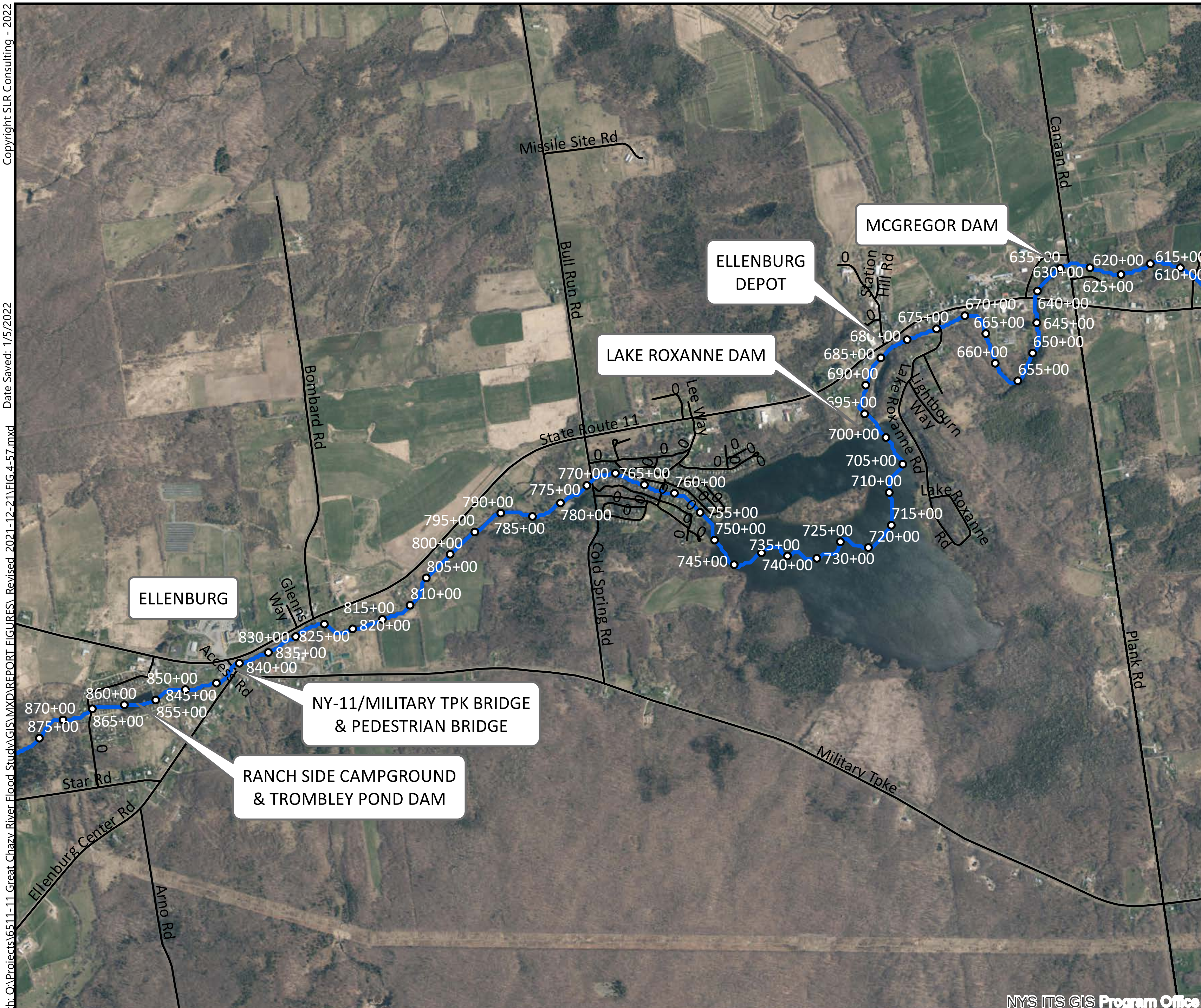

N

0 500 1,000
Feet

SLR

231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HIGH RISK AREA #5 - ELLENBURG

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY

SD119

CLINTON COUNTY
NEW YORK

SCALE 1 " = 2,000 '

DATE 1/5/2022

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FIG. 4-57

The Lake Roxanne Dam impounds the North Branch Great Chazy River in Ellenburg Depot at STA 697+00 (NYSDEC ID: 199-3718; Federal ID: NY13283). This Class B Intermediate Hazard dam is privately owned, and the 200-acre impoundment is used for recreation. It is a 17-foot-high concrete gravity dam constructed in 1967 and last inspected in 2017. Its condition is currently rated by NYSDEC as Unsound, with deficiency recognized. Repair or rehabilitation of this dam to meet current dam safety regulations is recommended; otherwise, removal of the dam is recommended. Deferment of corrective action is not recommended given the hazard to downstream life safety, property, and infrastructure in the case of failure. According to the NYSDEC dam inventory, this dam does not have an Engineering Assessment or an Emergency Action Plan on file; their completion is recommended.

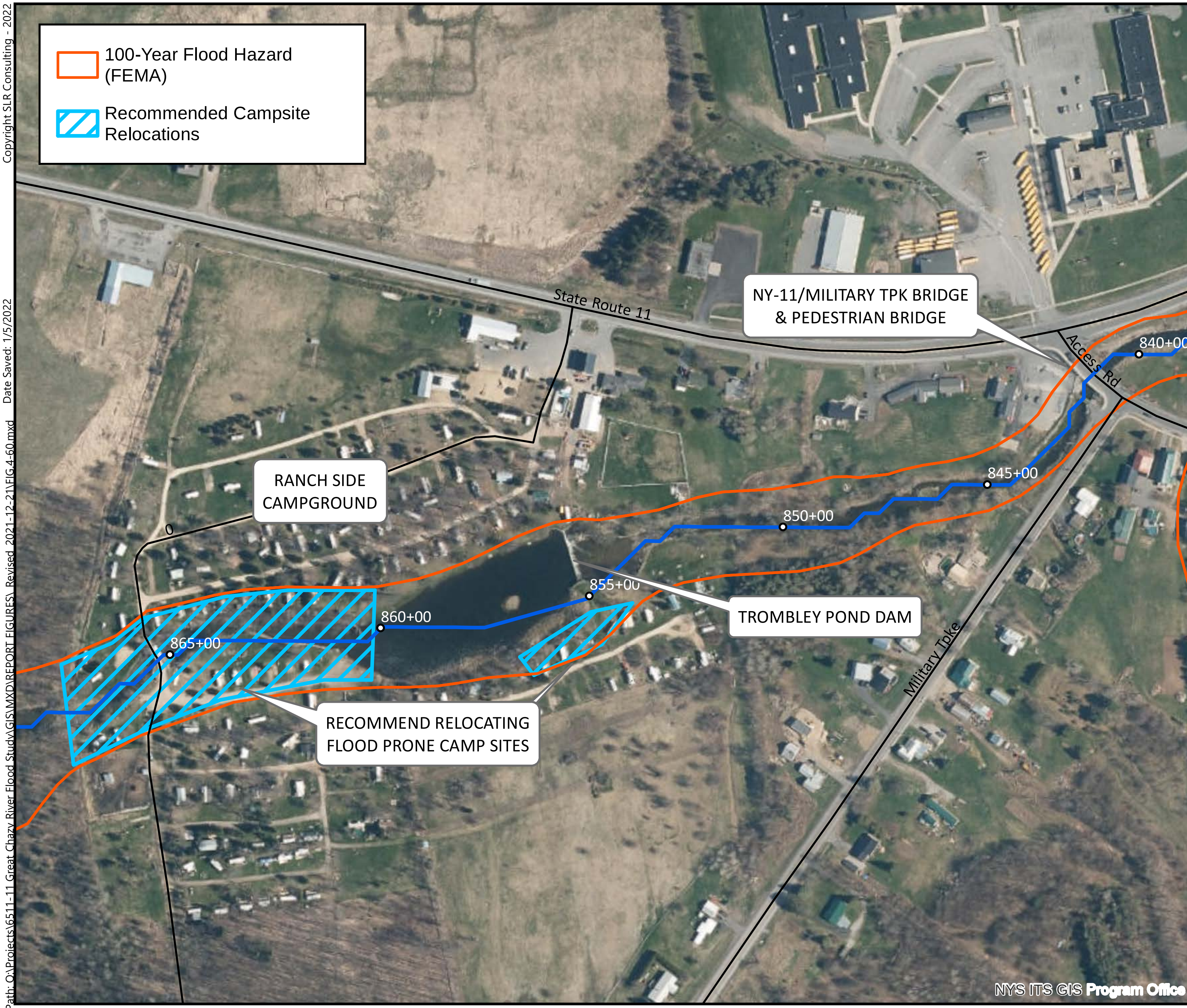
About 600 feet upstream of Lake Roxanne, a small dam is present at STA 761+00, which appears to serve as the headworks for a diversion channel that runs through the neighborhood on the north side of the lake. This dam is not included in the NYSDEC dam inventory (February 2021 Revision), and its inspection for inclusion in the database is recommended.

The NY-11/Military Turnpike bridge and a steel arch pedestrian bridge span the North Branch Great Chazy River at STA 841+20 and STA 821+80, respectively, and are shown in Figure 4-58. These bridges are undersized for flood flows, and debris jamming has been reported in past flood events; a vehicle was jammed in the bridge during 2018 flooding. Replacement of these crossings with minimum 95-foot single-span bridges is recommended in order to meet NYSDEC stream crossing standards of 1.25 times the bankfull width of approximately 76 feet. The steel arch pedestrian bridge is currently made redundant by a sidewalk on the NY-190/Military Turnpike intersection bridge so may be removed entirely.

Figure 4-58: Steel Arch Pedestrian Bridge with NY-11/Military Turnpike Intersection Bridge in Background

The Trombley Pond Dam at STA 855+00 is a Class A, Low Hazard, 6 foot tall concrete gravity dam built in 1973 for recreation and is privately owned (NYSDEC ID: 199-4097; Federal ID: NY13284). A last inspection by NYSDEC is not noted. Inspection and maintenance of this dam in good condition are recommended. The Ranch Side Campground is located along the banks of the North Branch Great Chazy River and the shores of Trombley Pond. Considerable damage has been incurred in the campground, with campers and trailers in the stream's immediate floodplain, shown in Figure 4-59. It is recommended that the campsites in the SFHA along the banks of the river, upstream of Trombley Pond, be relocated to higher ground, outside the flood-prone area as depicted in Figure 4-60.

Figure 4-59: Campers and RVs in the North Branch Great Chazy River's right bank floodplain in the Ranch Side Campground. River is out of frame just to the right.



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231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

HIGH RISK AREA #5 - ELLENBURG

GREAT CHAZY RIVER FLOOD & ICE JAM STUDY
SD119
CLINTON COUNTY
NEW YORK

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FIG. 4-60

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4.6 DAMS IN THE GREAT CHAZY WATERSHED

Many dams impound the Great 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 if not all of these dams are obsolete relative to their original purposes although some are currently used for recreation or to supply pump water for fire suppression in local communities, and the farthest-downstream dam on the river is currently operated by NYSDEC as a barrier to sea lamprey migration from Lake Champlain, discussed below. 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 Great 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 life span, the age and the condition of the reinforced concrete used in their construction are 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 (United States Bureau of Reclamation [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 Great Chazy 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 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 (discussed in Section 4.5; 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, which is discussed in Section 4.4). Overtopping damages included erosion of the left earthen closure embankment and undermining of the dam's left abutment, pictured in Figures 4-61 and 4-62. 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, pre-existing 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 4-61: 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 is provided by Clinton County Emergency Services.

Figure 4-62: Damage to McGregor Dam on North Branch Great Chazy River due to overtopping in August 2010. Canaan Road bridge is in background. Photo is provided by Clinton County Emergency Services.

The images in Figures 4-63 and 4-64 depict the LaSell Dam on the Great Chazy River (discussed in Section 4.4) after completion in the 1920s and in 2007 after nearly 50 years of abandonment, respectively. 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.

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.

Figure 4-63: LaSell Dam on the Great Chazy River in the 1920s. McGregor Powerhouse is in background.

Figure 4-64 – LaSell Dam 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.

Seven dams on the Great Chazy River, listed below, were identified in the field or with aerial imagery that are not included in NYSDEC's current dam inventory (February 2021 Revision):

- the partially breached Perry Mills sawmill dam at STA 527+00,
- the dam at the defunct LaSell Powerhouse at STA 1497+00,
- the McGregor Powerhouse building at STA 1640+00,
- the series of three low-head dams just upstream of the McGregor Powerhouse at STA 1642+10, STA 1642+50, and STA 1644+80,
- and, on the North Branch Great Chazy River at STA 761+00, just upstream of Lake Roxanne.

It is recommended that these be inspected for inclusion in the database.

Many dams in the Great Chazy 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, upstream backwater flooding, ice generation, and ice accumulation. 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.

Where appropriate, it is recommended that NYSDEC take necessary action to compel responsible dam ownership as described 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.

Some communities rely on water withdrawn from old dams on the Great 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 4-65.

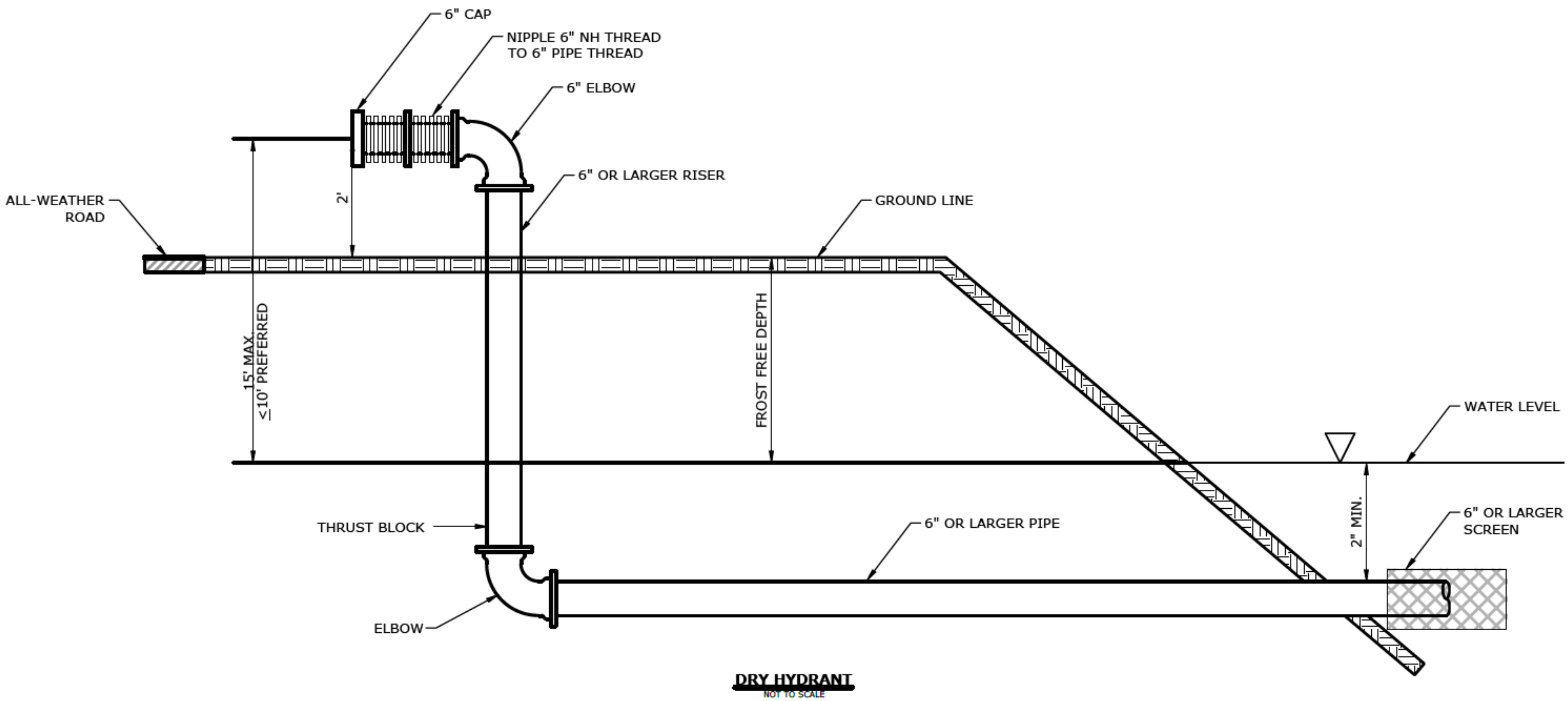


Figure 4-65: Typical Dry Hydrant Detail

4.6.1 SEA LAMPREY EXCLUSION

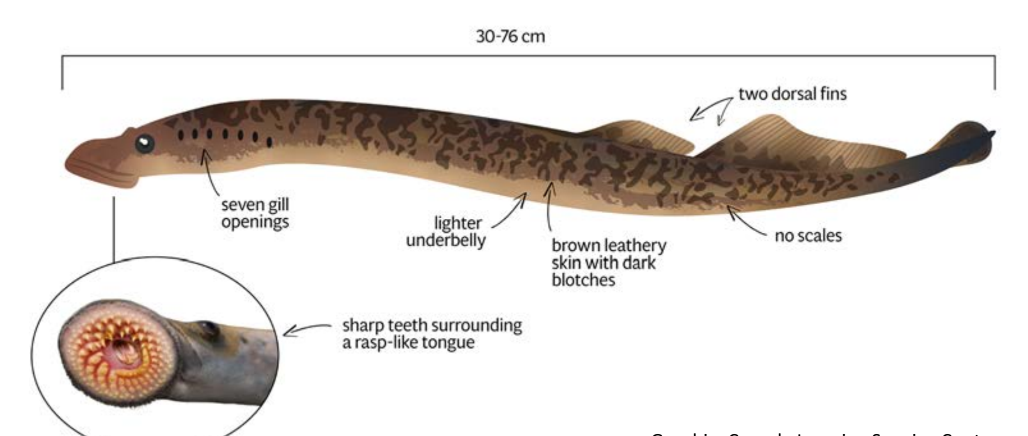
Maintenance of an effective sea lamprey barrier to inhibit migration of this invasive species upstream from Lake Champlain is an important ecological objective for NYSDEC. On the Great Chazy River, the 9-foot-high Whiteside Dam at STA 403+00 currently serves this purpose and is owned and maintained by NYSDEC. As described in Section 4.1 of this report, this dam also contributes to upstream backwater flooding, and excess ice generation, and solid, potentially anchored ice in the impoundment creates an accumulation point for break-up ice, which can impact the Creek Road bridge upstream. NYSDEC and USFWS have established that the natural bedrock falls at this dam's location cannot effectively meet lamprey exclusion objectives. If so, removal of the Whiteside Dam is recommended. Therefore, 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 (Great Lakes Fishery Commission [GLFC] 2014). Six 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 the distance and time achievable is very low (Katopodis et al. 1994). Ten fps is considered to be a high end of velocity for upstream travel.



Graphic: Canada Invasive Species Centre

4.7 OTHER STRUCTURES IN THE GREAT CHAZY WATERSHED

In addition to dams, other obsolete or damaged structures are present throughout the Great Chazy River channel and its tributaries. This includes substructural elements of old road and railroad 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 safety hazards. A number of intact but abandoned or derelict bridges also span the Great Chazy River and its tributaries.

The piers that once supported penstocks for defunct hydroelectric projects are located along reaches of the Great Chazy River, specifically noted in HRA 4. Many of these large concrete piers are located directly in the stream channel and immediate overbanks and are therefore prone to snagging debris and ice in addition to restricting the passage of floodwaters. Some of these may also pose a safety hazard. Removal of all such archaic features that obstruct or contract flows in the channel and floodplain is recommended.

5. RECOMMENDATIONS

The 304-square-mile Great Chazy River watershed is located primarily in Clinton County and flows in a generally northeasterly direction, draining the northwestern and northeastern portions of the county before flowing into Lake Champlain at King Bay. Flood mitigation recommendations are provided either as HRA-specific recommendations or as overarching recommendations that apply to the entire watershed or stream corridor or to specific topics such as dams. 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.

5.1 HRA 1 RECOMMENDATIONS

When due for replacement or significant repair or upgrade, replacement of the CP railway bridge and NY-9B/Lake Street bridge with 200-foot span structures is recommended.

Voluntary buyouts and the creation of approximately 800 feet of floodplain benching along Water Street and 700 feet of floodplain reclamation along Church Street are recommended.

The replacement of the current 100-foot US-9 bridge with a 180-foot single-span structure is recommended.

Relocation of Paquette Park to the northern end of the River Street Park, across Elm Street from the Samuel de Champlain Museum, is recommended.

Floodplain reclamation along the 300 feet of the right bank at the current site of Paquette Park and immediately upstream is recommended, along with further floodplain enhancement in River Street Park along 1,200 feet of the Great Chazy's left bank, downstream of the proposed Paquette Park relocation.

These modifications would then allow the 100-foot Elm Street bridge to be replaced with a single-span 185-foot crossing, which is recommended. The proposed floodplain enhancements should be designed to accommodate ice rafting and account for the presence of the village wastewater treatment plant about 1,500 feet downstream of the Elm Street bridge.

The voluntary buyout and relocation of flood-prone properties is recommended, as depicted in the conceptual relocation master plan for HRA 1.

5.2 HRA 2 RECOMMENDATIONS

Modification of the Whiteside Dam to significantly reduce the spillway elevation is recommended.

Reduction of the spillway crest to the minimum acceptable height that achieves this sea lamprey exclusion objectives, or replacement with a purpose-built lamprey barrier is recommended.

Removal of the abutments and central pier of the abandoned railroad crossing just downstream of the Whiteside Dam at STA 402+50 is recommended. The abutments may not be easily separable from components of the dam; therefore, their removal may not be practical unless accompanied by dam removal or modification.

This abandoned railway also spanned the Great Chazy River upstream at STA 550+00, upstream of the breached Perry Mills dam and USGS gauge. The raised approach embankment on the right (east) bank is between 10 and 15 feet tall and protrudes over 300 feet into the river's active floodplain. Removal of this section of embankment is recommended, along with restoration of the adjacent channel and floodplain to restore its function and reduce the potential for ice accumulation at this contraction.

At the end of its service life or when due for significant upgrades, replacement of the Creek Road bridge with a 170-foot span is recommended. Replacement should be accompanied by updated detailed hydrologic and hydraulic analyses, and the most current regulations and guidance from NYSDOT and NYSDEC regarding stream crossing geometry and hydraulic performance should be applied, as well as updated assessments of projected future flows.

Removal of the remaining components of the unused and partially breached Perry Mills sawmill dam at STA 527+00 is recommended to reduce the downstream hazard and potential for ice and debris accumulation.

It is recommended that the Perry Mills sawmill dam be included in the NYSDEC's dam inventory.

The voluntary buyout and relocation of flood-prone properties is recommended, as depicted in the conceptual relocation master plan for HRA 2.

5.3 HRA 3 RECOMMENDATIONS

Removal of the Mooers Dam at STA 1084+50 is recommended, along with replacement of the existing fire suppression appurtenances with conventional dry hydrant systems that do not require impoundment of the river. A typical dry hydrant detail is shown in Figure 4-65. This dam contributes to ice formation in the winter, and sediment aggradation in the impoundment can lead to channel instability both from deposition upstream and sediment starvation downstream. Removal should be delayed until NYSDEC has completed sea lamprey exclusion repairs at Whiteside Dam and treated for lamprey downstream of Mooers.

The CR-34/East Street bridge at STA 1084+00, immediately downstream of the Mooers Dam, was built in 1888 and taken out of service in 1983 when it was functionally replaced by the NY-22 bridge 500 feet upstream. It is currently closed to vehicle and pedestrian traffic. The bridge does not appear to contribute substantially to upstream flooding, but if it is to remain for its historical significance, it should be kept in good condition to avoid potential hazards from developing in the future. It is recommended that this structure either be rehabilitated as a pedestrian crossing and regularly inspected and maintained, or removed.

Removal of the remaining components of the Shefield Dam at STA 1201+00 is recommended, along with restoration of the adjacent reach of the Great Chazy River. The approximately 75 feet of the dam that remains in the channel and overbanks appears to be generating channel instability in the forms of bank erosion, bar formation, and consequent lateral migration.

The voluntary buyout and relocation of flood-prone properties is recommended, as depicted in the conceptual relocation master plan for HRA 3.

5.4 HRA 4 RECOMMENDATIONS

It is recommended that the existing twin-barrel, cast-in-place concrete box culvert that carries Devil's Den Road over the Great Chazy River be replaced with a minimum 90-foot single-span bridge with sufficient rise above the channel to pass projected future floods with adequate freeboard. Replacement should be accompanied by updated detailed hydrologic and hydraulic analyses. The most current regulations and guidance from NYSDOT and NYSDEC regarding stream crossing geometry and hydraulic performance should be applied, as well as updated assessments of projected future flows.

Removal of the numerous piers and substructural elements that formerly supported penstocks from the McGregor and LaSell Dams and Powerhouses between STA 1642+50 and STA 1500+00 is recommended. Many of these are located directly in the stream channel, obstructing flood flows, and are prone to snagging debris and ice. Removal of all such structures from the river and its floodplain is recommended.

Removal of the central pier and any other remaining substructural elements of the abandoned bridge crossing at STA 1551+00 and restoration of the adjacent reach of channel are recommended.

It is recommended that the three low-head dams upstream of the McGregor Powerhouse (STA 1642+10, STA 1642+50, and STA 1644+80), as well as the powerhouse itself (STA 1640+00) be inspected by NYSDEC and all four added to its inventory of dams. Exploring the feasibility of removal or modification of these four structures is recommended as well. It is also recommended that the dam located at STA 1497+00, at the site of the LaSell Powerhouse just upstream of the Great Chazy River's confluence with Bradford Brook, be inspected by NYSDEC for inclusion in its database. Removal of this obsolete dam and restoration of the Great Chazy River's flow path, away from CR-15/Joe Wood Road, are recommended.

The voluntary buyout and relocation of flood-prone properties are recommended, as depicted in the conceptual relocation master plan for HRA 4.

5.5 HRA 5 RECOMMENDATIONS

Removal of the McGregor Dam at STA 635+00 on the North Branch of the Great Chazy River is recommended (note: this dam has the same name as the larger McGregor Dam that impounds the main stem of the Great Chazy River to create Miner Lake, which is discussed in Section 4.3). Replacement of any necessary existing irrigation intakes with dry hydrant systems that do not require impoundment of the river is recommended.

Rehabilitation or repair of the Lake Roxanne Dam at STA 697+00 on the North Branch Great Chazy River in Ellenburg Depot to meet current dam safety regulations is recommended. This Class B Intermediate Hazard dam's condition is currently rated by NYSDEC as Unsound, with deficiency recognized. Owners of "Unsafe," "Unsound," or otherwise deficient dams are in violation of 6 NYCRR Part 673 and ECL § 15-0507. If repair is not practical, removal of the dam is recommended. Deferment of corrective or remedial action is not recommended given the hazard to downstream life safety, property, and infrastructure in the case of failure. Completion of an Engineering Assessment and Emergency Action Plan for this dam is recommended as neither is currently on file. An emergency action plan is generally not required for a Class B dam, however NYSDEC Dam Safety Section has requested that one be completed for this dam. It is recommended that NYSDEC take necessary actions to enforce the responsibilities of dam ownership set forth in 6 NYCRR Part 673 and ECL § 15-0507.

The steel arch pedestrian bridge at the intersection of NY-11 and Military Turnpike is prone to debris and ice jamming. An alternative pedestrian crossing is available via the sidewalk on the NY-190 bridge immediately downstream. Removal of this bridge or replacement with a 95-foot span is recommended. The NY-11/Military Turnpike crossing is undersized for flood flows, and replacement with a 95-foot span is recommended.

In the Ranch Side Campground, it is recommended that RVs, campers, and trailers that are located in the immediate floodplain be relocated to higher ground elsewhere in the campground. Regular inspection and maintenance in good condition of the Trombley Pond Dam are recommended.

5.6 REMOVAL OF DAMS AND OTHER STRUCTURES

In addition to the dams and other structures evaluated and discussed in the HRAs 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.

A number of intact but abandoned or derelict bridges also span the Great 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 emergency access or significant historical value.

The piers that once supported penstocks for defunct hydroelectric projects are located along reaches of the Great Chazy River, specifically noted in HRA 3. Many of these large concrete piers are located directly in the stream channel and immediate overbanks and are therefore prone to snagging debris and ice in addition to restricting the passage of floodwaters. Some of these may also pose a safety hazard. Removal of all such archaic features that obstruct or contract flows in the channel and floodplain is recommended.

Removal of such dams should be prioritized. 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.

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.

Table 5-1: Dams Not Found in NYSDEC Dam Inventory (February 2022 Revision). Horizontal Datum: NAD83 NY State Plane East

WATERCOURSE	RIVER STATION	NORTHING (FT)	EASTING (FT)	DESCRIPTION	MAPPING
Great Chazy River	527+00	2245450	749480	Perry Mills Dam, partially breached	Figure 4-22
	1497+00	2214585	716090	LaSell Powerhouse site, channel avulsed into Bradford Brook alignment	Figure 4-55
	1640+00	2203900	709840	McGregor Powerhouse building spanning channel	Figure 4-44B
	1642+10	2203805	709700	Low-head concrete dam upstream of McGregor Powerhouse	Figure 4-44B
	1642+50	2203800	709655	Low-head concrete dam upstream of McGregor Powerhouse	Figure 4-44B
	1644+80	2203735	709440	Low-head concrete dam upstream of McGregor Powerhouse	Figure 4-44B
North Branch Great Chazy River	761+00	2210720	669300	Upstream of Lake Roxanne, diverts flows to channel through neighborhood to north	Figure 4-57

5.7 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 the HRAs described above, it is recommended that undersized stream crossings elsewhere in the Great 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.

5.8 STREAM GAUGING

The existing stream gauge on the Great Chazy River at Perry Mills (04271500) is poorly sited to capture the entirety of the basin's discharge during flood events. The value of this gauge's record is therefore limited in this regard. It is recommended that an additional gauging station be installed roughly 8 miles upstream, at a site where the river's flow is confined to a single path. This will enable more accurate measurements of the basin's total discharge in flood events and provide valuable data regarding the proportion of floodwaters that bypass the existing gauge. Hydraulic modeling and topographic analysis indicate that floodwaters are able to access distributary channels beginning almost immediately downstream of the CR-20/Angelville Road crossing. The river is significantly more confined as it runs along CR-21/Lavalley Road downstream of the hamlet of Mooers, and this appears to be an appropriate location for a stream gauge to capture all of the contributing watershed's runoff.

Development of a two-dimensional hydraulic model that extends from the hamlet of Mooers to Lake Champlain is recommended. The model domain should encompass all identified distributary flow paths and include all hydraulic structures (bridges, culverts, dams) in order to make a reliable assessment of floodwaters that bypass the existing gauge. To calibrate this model, total watershed discharge can be determined iteratively based on the flows recorded at the gauge in past flood events. This model may be used to update both the USGS and NERFC stage-discharge rating curves for the Great Chazy River and assist the National Weather Service (NWS) and Northeast River Forecast Center (NERFC) to more accurately project flood stage at the Perry Mills gauge and the village of Champlain downstream.

5.9 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.

5.10 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 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.

5.11 INDIVIDUAL PROPERTY FLOOD PROTECTION

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

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

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

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

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

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

- Relocate valuable belongings above the 100-year flood elevation to reduce the amount of damage caused during a flood event.
- Relocate or elevate water heaters, heating systems, washers, and dryers to a higher floor or to at least 2 feet above the BFE (if the ceiling permits). A wooden platform of pressure-treated wood can serve as the base.
- Anchor the fuel tank to the wall or floor with noncorrosive metal strapping and lag bolts.
- Install a backflow valve to prevent sewer backup into the home.
- Install a floating floor drain plug at the lowest point of the lowest finished floor.
- Elevate the electrical box or relocate it to a higher floor and elevate electric outlets.

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

5.12 ROAD CLOSURES

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

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

According to FEMA modeling and anecdotal reporting, flood-prone roads exist within the 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.

5.13 ROUGH ORDER OF MAGNITUDE COST RANGE OF RECOMMENDED ACTIONS 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	> $5M
HRA 1 Elm Street bridge replacement					X
HRA 1 US-9 bridge replacement					X
HRA 1 floodplain enhancements for ice jam mitigation				X	
HRA 2 Remove/modify/replace Whiteside Dam (sea lamprey barrier)			X		
HRA 2 Remove Perry Mills Dam remnants		X			
HRA 2 Remove abandoned RR embankment/former bridge approach				X	
HRA 2 Replace Creek Road bridge				X	

	< $100k	$100k - $500k	$500k - $1M	$1M - $5M	> $5M
HRA 3 Rehabilitate/maintain or remove old CR34/East Street bridge			X		
HRA 3 Remove Mooers Dam and replace fire suppression system[1]			X		
HRA 3 Remove remaining components of Shefield Dam[1]		X			
HRA 4 Replace Devils Den Road culverts with 90 foot bridge				X	
HRA 4 Remove components of derelict hydropower projects from river and overbanks[1]			X		
HRA 4 Remove three low head dams upstream of McGregor Powerhouse[1]				X	
HRA 4 Feasibility study for rehabilitation/modification/removal of McGregor Powerhouse	X				
HRA 4 Remove dams/tailraces at LaSell powerhouse; restore channel[1]			X		
HRA 5 Relocate campers/trailers/RVs from floodplain at Ranchside Campground	X				
HRA 5 Remove McGregor Dam on North Branch Great Chazy River[1]			X		
HRA 5 Rehabilitate or remove Lake Roxanne Dam[1]			X		
HRA 5 Upgrade pedestrian and vehicle crossings at NY-190/US-11				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.

5.14 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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