EMERGENCY TRANSPORTATION INFRASTRUCTURE RECOVERY
WATER BASIN ASSESSMENT
AND FLOOD HAZARD MITIGATION ALTERNATIVES

STEELE CREEK
HERKIMER COUNTY, NEW YORK

April 2014

MMI #5231-01

Photo Source: Milone & MacBroom, Inc. (2013)

This document was prepared for the New York State Department of Transportation, in cooperation with the New York State Department of Environmental Conservation.

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ABBREVIATIONS/ACRONYMS

BCA	Benefit-Cost Analysis
BCR	Benefit Cost Ratio
BIN	Bridge Identification Number
CFS	Cubic Feet per Second
CME	Creighton Manning Engineering
DART	Damage Assessment Response Team
D/S	Downstream
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FT	Feet
FTP	File Transfer Protocol
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center – River Analysis System
HMA	Hazard Mitigation Assistance
HMPG	Hazard Mitigation Grant Program
LiDAR	Light Detection and Ranging
MMI	Milone & MacBroom, Inc.
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York State Department of State
NYSDOT	New York State Department of Transportation
PDM	Pre-Disaster Mitigation
SFHA	Special Flood Hazard Area
Sq. Mi.	Square Mile
STA	River Station
U/S	Upstream
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
YR	Year

1.0 INTRODUCTION

1.1 Project Background

A severe precipitation system in June 2013 caused excessive flow rates and flooding in a number of communities in the greater Utica region. As a result, the New York State Department of Transportation (NYSDOT) in consultation with the New York State Department of Environmental Conservation (NYSDEC) retained Milone & MacBroom, Inc. (MMI) through a subconsultant agreement with Creighton Manning Engineering (CME) to undertake a comprehensive water basin assessment of 13 watersheds in Herkimer, Oneida, and Montgomery Counties, including Steele Creek. Prudent Engineering was also contracted through CME to provide support services, including field survey of stream cross sections.

Work conducted for this study included field assessment of the watersheds, streams, and rivers; analysis of flood mitigation needs in the affected areas; hydrologic assessment; hydraulic modeling; and identification of long-term recommendations for mitigation of future flood hazards.

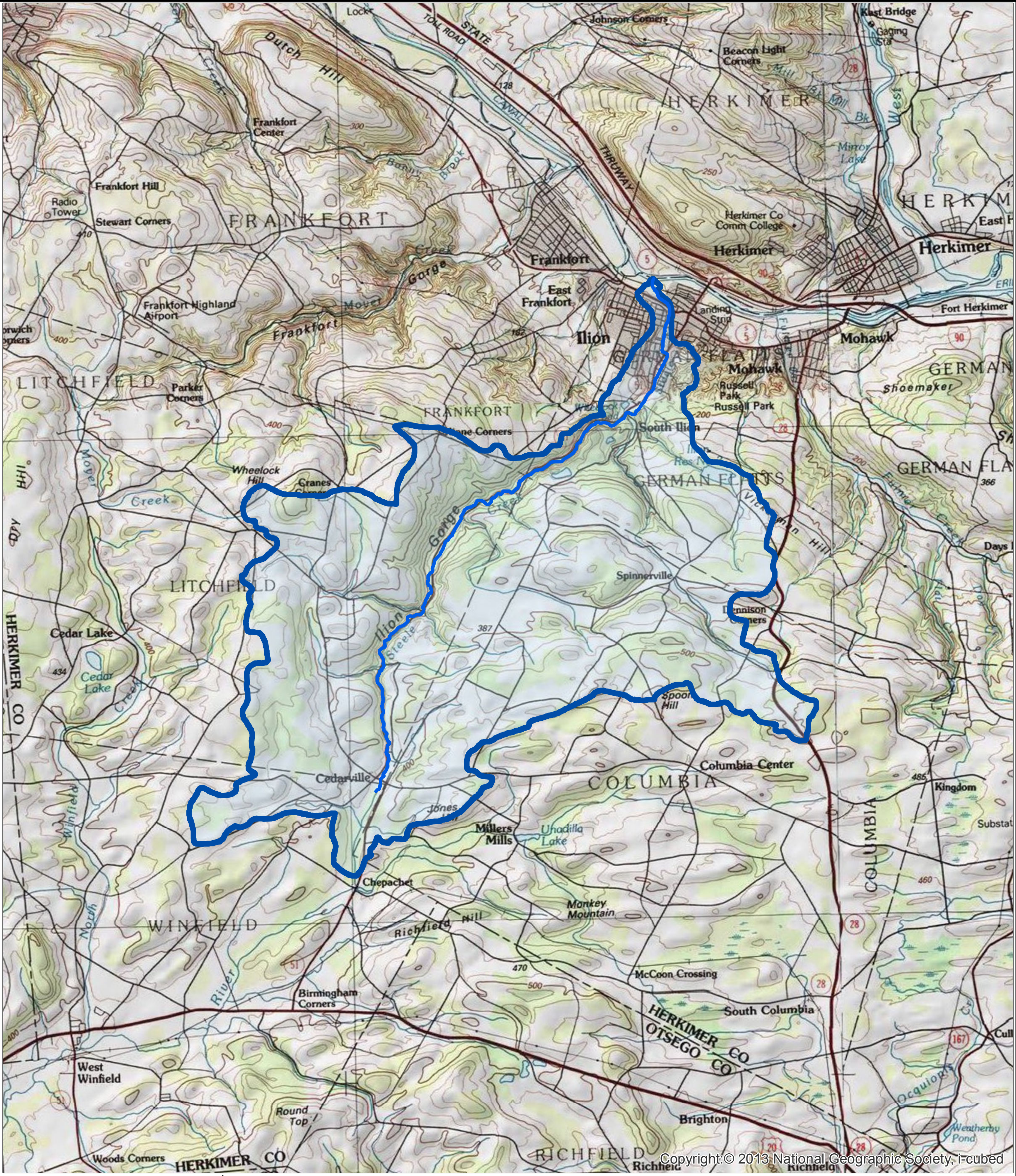
The Steele Creek drainage basin is located primarily in the towns of Litchfield, German Flatts, and Columbia, and the village of Ilion, in Herkimer County, east central New York State. Smaller portions of the basin are located in the towns of Winfield and Frankfort. The creek drains an area of 27.3 square miles. The drainage basin is approximately 47 percent forested with rural residential and agriculture uses throughout the basin and a mix of residential and commercial land uses concentrated in the lower part of the basin in the village of Ilion. The creek has an average slope of 1.75 percent over its entire stream length of 12.9 miles. Figure 1 depicts the contributing watershed of Steele Creek.

Steele Creek generates a significant amount of stream power through certain reaches during high flow events. Due to historic filling and development that has occurred, numerous bridges and sections of channel along the watercourse are not large enough to convey flows during significant storm events. An extensive area of commercial and residential development in the village of Ilion occurs in the floodplain and in many cases is within 20 feet or less of the edge of the stream. When the channel exceeds its hydraulic capacity or becomes clogged with sediment and woody debris, it finds new and destructive paths through the community, leaving homes and property damaged by floodwaters, bridges destroyed, and unstable creek bed and banks that are at risk for further degradation and failure.

The goals of the subject water basin assessment are to:

1. Collect and analyze information relative to the June 28, 2013 flood and other historic flooding events.

2. Identify critical areas subject to flood risk.



SOURCE(S):	Figure 1: Steele Creek Drainage Basin Location Map	LOCATION: Herkimer County, New York

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NYDOT: Emergency Transportation Infrastructure Recovery

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MMI#: 5231-01
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Revision: 1/6/2014
Scale: 1 inch = 8,500 feet

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3. Develop and evaluate flood hazard mitigation alternatives for each high risk area within the stream corridor.

1.2 Nomenclature

In this report and associated mapping, stream stationing is used as an address to identify specific points along the watercourse. Stationing is measured in feet and begins at the mouth of Steele Creek at STA 0+00 and continues upstream to STA 490+00. As an example, STA 73+00 indicates a point in the channel located 7,300 linear feet upstream of the mouth. Figure 2 depicts the stream stationing along Steele Creek.

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

2.0 DATA COLLECTION

2.1 Initial Data Collection

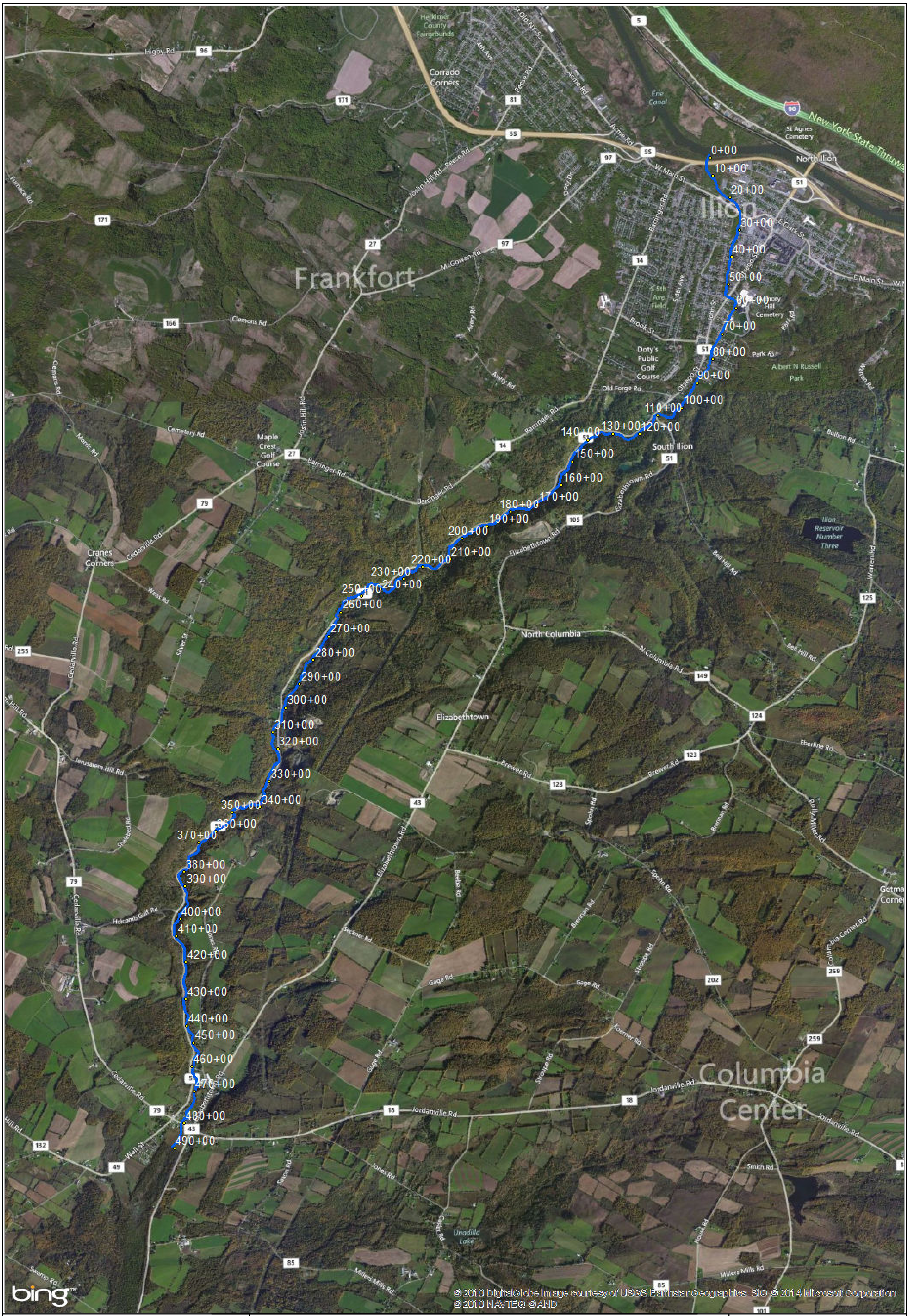
Public information pertaining to Steele Creek was collected from previously published documents as well as through meetings with municipal, county, and state officials. Data collected includes reports, photographs, newspaper articles, Federal Emergency Management Agency (FEMA) Flood Insurance Studies (FIS), aerial photographs, and geographic information system (GIS) mapping. Appendix A is a summary listing of data and reports collected.

2.2 Public Outreach

An initial project kickoff meeting was held in early October 2013 with representatives from NYSDOT and NYSDEC, followed by public outreach meetings held in the affected communities, including a meeting held in the village of Ilion to discuss Steele Creek. These meetings provided more detailed, firsthand accounts of past flooding events; identified specific areas that flooded in each community and the extent and severity of flood damage; and provided information on post-flood efforts such as bridge reconstruction, road repair, channel modification, and dredging. This outreach effort assisted in the identification of target areas for field investigations and future analysis.

2.3 Field Assessment

Following initial data gathering and outreach meetings, field staff from Prudent Engineering and MMI undertook field data collection efforts, with special attention given to areas identified in the outreach meetings. Initial field assessment of all 13 watersheds was conducted in October and November 2013. Selected locations identified in the initial phase were assessed more closely by multiple field teams in late November 2013. Information collected during field investigations included the following:



SOURCE(S):	Figure 2: Steele Creek Watercourse Stationing	Location: Herkimer County, New York

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- Rapid "windshield" river corridor inspection
- Photo documentation of inspected areas
- Measurement and rapid hydraulic assessment of bridges, culverts, and dams
- Geomorphic classification and assessment, including measurement of bankfull channel widths and depths at key cross sections
- Field identification of potential flood storage areas
- Wolman pebble counts
- Cohesive soil shear strength measurements
- Characterization of key bank failures, headcuts, bed erosion, aggradation areas, and other unstable channel features
- Preliminary identification of potential flood hazard mitigation alternatives, including those requiring further analysis

Included in Appendix B is a copy of the River Assessment Reach Data Form, River Condition Assessment Form, Bridge Waterway Inspection Form, and Wolman Pebble Count Form. Appendix C is a photo log of select locations within the river corridor. Field Data Collection Index Summary mapping has been developed to graphically depict the type and location of field data collected. Completed data sheets, field notes, photo documentation, and mapping developed for this project have been uploaded onto the NYSDOT ProjectWise system and the project-specific file transfer protocol (FTP) site at MMI. The data and mapping were also provided electronically to NYSDEC.

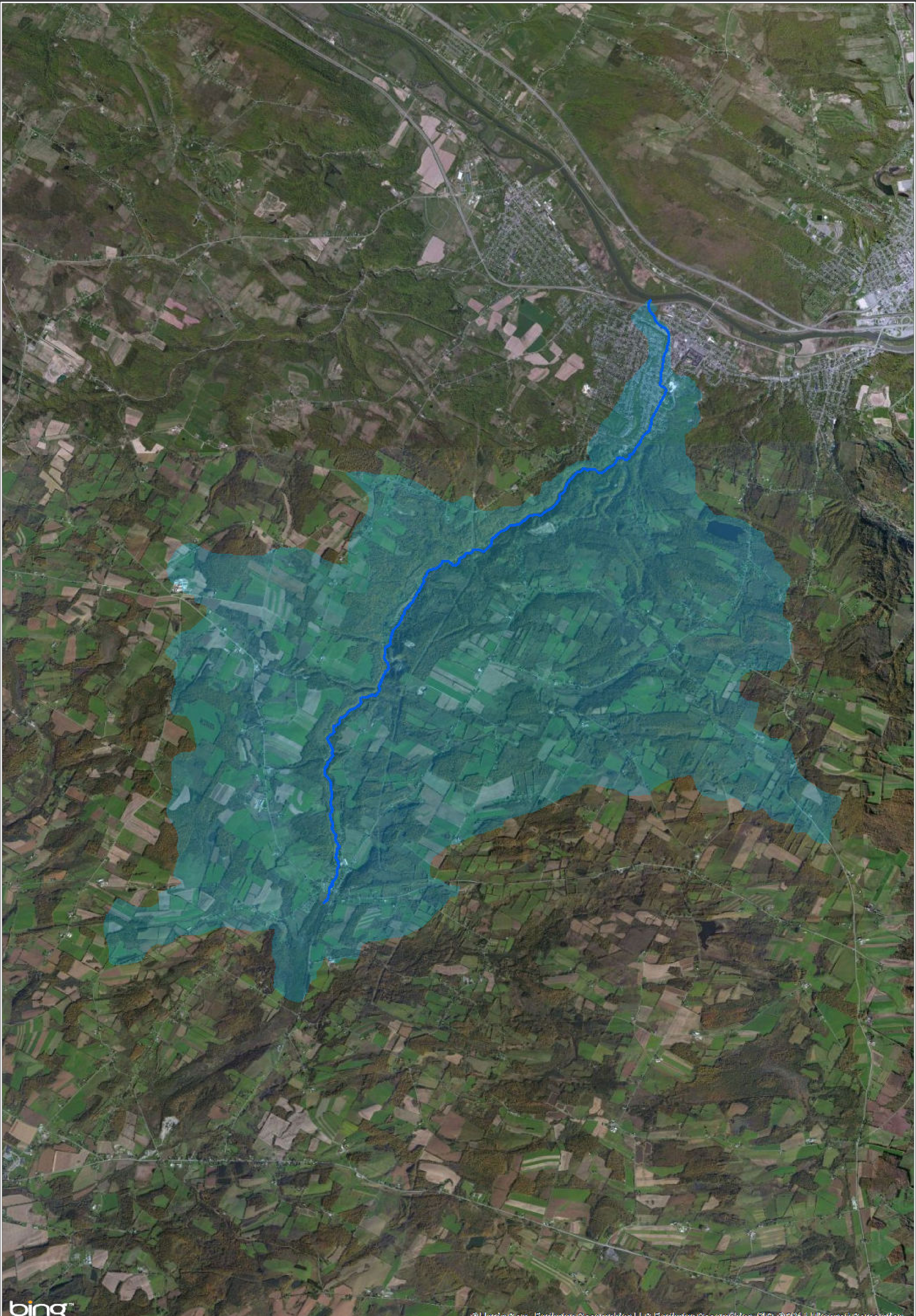
2.4 Watershed Land Use

Figure 3 is a watershed map of Steele Creek. The Steele Creek drainage basin is located primarily in the towns of Litchfield, German Flatts, and Columbia and the village of Ilion. Smaller portions of the basin are located in the towns of Winfield and Frankfort. The basin drains an area of 27.3 square miles. The Steele Creek drainage basin is approximately 47 percent forested, with rural residential and agriculture uses throughout the basin and a mix of residential and commercial land uses concentrated in the lower part of the basin in the village of Ilion.

The stream corridor is a patchwork of agricultural and forested lands as the creek flows from its headwaters in a wetland south of Cedarville, through the hamlet of Cedarville, and into Ilion Gorge. Through Ilion Gorge, Steele Creek is heavily forested along both of its banks, with the exception of a quarry operation on the right bank in the vicinity of STA 320+00. The Steele Creek corridor becomes more urbanized downstream of the confluence with Spinnerville Gulf.

2.5 Geomorphology

Steele Creek flows for a length of 12.9 miles in a north and northeasterly direction, from its headwaters south of the hamlet of Cedarville, through Ilion Gorge, and through the village of Ilion to its outlet at the Mohawk River. Steele Creek has several tributaries including Clapsaddle Creek, Holcomb Gulf, Beckus Gulf, and Spinnerville Gulf Brooks.



SOURCE(S):	Figure 3: Steele Creek Drainage Basin Aerial		Location: Herkimer County, New York
	N **NYDOT: Emergency Transportation Infrastructure Recovery**	**Map By:** CMP **MMI#:** 5231-01 **MXD:** Y:\5231-01\GIS\Maps\Figure 3 Maps\Figure 3 Steele Creek.mxd **1st Version:** 01/06/2014 **Revision:** 1/6/2014 **Scale:** 1 in = 5,000 ft	MILONE & MACBROOM 99 Realty Drive Cheshire, CT 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com

Steele Creek exhibits evidence of high sediment load in the main channel and tributaries. It is evident that the stream has been recently dredged within some reaches for the purpose of removing accumulated sediment. In some of these areas, dredged materials have been placed directly on the stream banks or in the floodplain. Sediment sources include bedload from higher in the watershed, and eroding banks and minor bank failures.

For much of its length in the upper part of the watershed, Steele Creek parallels Route 51 through a rural landscape. After crossing beneath the Spinnerville Gulf Road bridge (STA 112+50), the creek is lined with stacked rock walls and other bank stabilization features for much of its length. From STA 80+00 downstream to STA 63+00, Steele Creek flows through a highly channelized reach between vertical concrete walls and over a 10-foot-high dam, known locally as "The Falls" at STA 64+75. The creek is bordered by roads and residential development on both banks, leaving little to no natural floodplain.

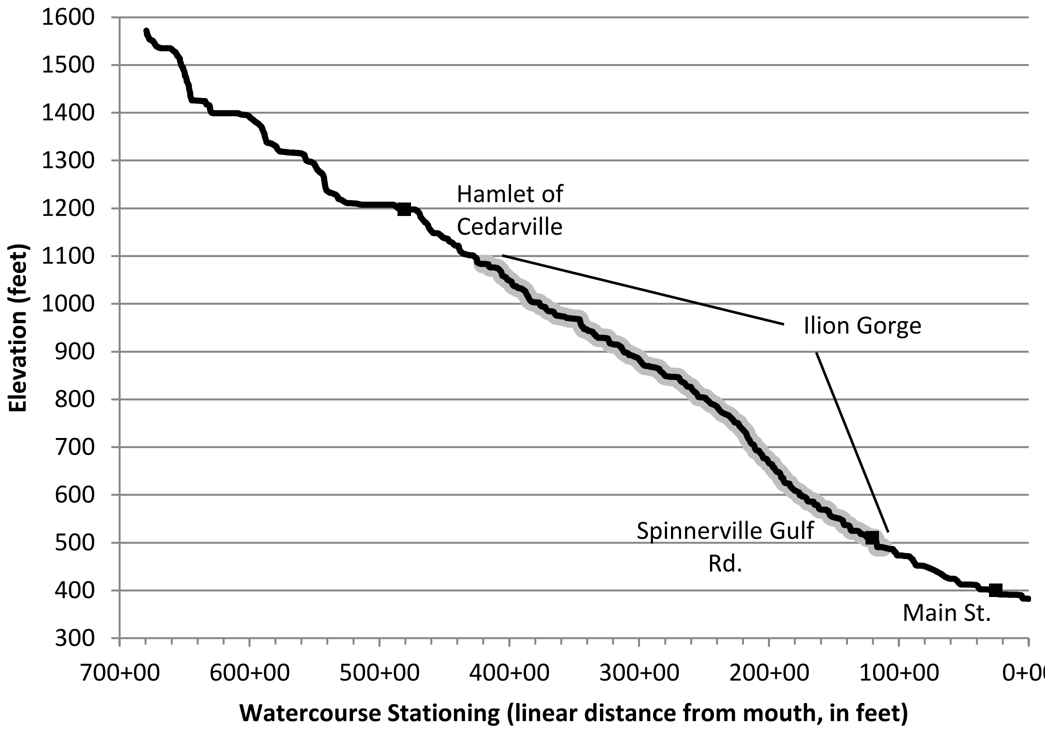
After crossing under Otsego Street (STA 56+00), Steele Creek flows through a dense residential neighborhood, where various stacked rock and concrete walls line the channel. As it passes under the West Main Street bridge (STA 25+50), the channel is lined with concrete for a distance of approximately 600 feet.

According to community officials, in the past, Department of Public Works crews from the village of Ilion would remove cobble and debris from Steele Creek. Materials were completely removed from the stream corridor where feasible. However, due to difficulties with access, the excavated materials were often left on the creek banks. Community officials report that the stream channel in the vicinity of the Main Street bridge is cleaned out each year by October 1. Sediment is also regularly removed from the channel in the vicinity of the dam at STA 64+75.

Figure 4 is a profile of Steele Creek, showing the watercourse elevation versus the linear distance from the mouth of the watercourse. Steele Creek has an average slope of 1.75 percent over its length of 12.9 miles. The creek has a fairly uniform slope, dropping a total of 1,190 vertical feet over its entire length, from an elevation of 1,572 feet above sea level at its headwaters upstream of Cedarville, to an elevation of 382 feet at its outlet at the Mohawk River. The creek flattens somewhat after it passes under Spinnerville Gulf Road (STA 113+50) and flows through the more densely populated village of Ilion, beneath the Main Street bridge (STA 25+50) to its outlet at the Mohawk River (STA 0+00). The average slope of this lower portion of Steele Creek is 1 percent.

Steeper stream reaches such as seen in upper Steele Creek have more energy than lower gradient reaches and, as a result, have higher velocities and can carry more sediment. These mobilized sediments are deposited in lower gradient reaches lower in the watershed, where they clog the channel and reduce hydraulic capacity, exacerbating flooding.

Figure 4
Steele Creek Profile



2.6 Hydrology

Alluvial river channels adjust their width and depth around a long-term dynamic equilibrium condition that corresponds to "bankfull" conditions. Extensive data sets indicate the channel forming or bankfull discharge in specific regions is primarily a function of watershed area and soil conditions. The bankfull width and depth of alluvial channels represent long-term equilibrium conditions and are important geophysical criteria that are used for design. Table 1 on the following page lists estimated bankfull discharge, width, and depth at several points along Steele Creek, as derived from the United States Geological Survey (USGS) *StreamStats* program.

Actual bankfull widths measured on Steele Creek were compared to the regional bankfull channel dimensions reported above. These comparisons indicate that the Steele Creek stream channel is undersized as it flows through the more populated areas of the basin. This is due to historic filling and confinement of the channel between vertical walls along both stream banks.

There are no USGS stream gauging stations on Steele Creek. Hydrologic data on peak flood flow rates are available from the FEMA FIS and from *StreamStats* regional statistical data.

TABLE 1
Estimated Bankfull Discharge, Width, and Depth
(Source: USGS *StreamStats*)

Location	Station	Watershed Area (sq. mi.)	Discharge (cfs)	Bankfull Width (ft)	Bankfull Depth (ft)
U/S of Spinnerville Gulf Road	116+00	19.3	571	51.0	2.47
D/S of dam at "the falls"	69+50	26.4	746	58.7	2.78
3rd Street crossing	42+50	27.1	763	59.4	2.81
West Main Street crossing	25+50	27.2	766	59.5	2.81

The most recent FEMA FIS that applies to Steele Creek is for the Town of Litchfield, with an effective date of September 24, 1984 and a revision date of May 7, 2001. There is a preliminary draft FIS available for all of Herkimer County, which was issued September 30, 2011 but had not yet been formally approved as of the publication of the subject document. According to this more recent, draft FIS, the most recent hydraulic modeling for Steele Creek dates from February 1999 and December, 2004.

The hydrologic analysis methods employed in the FEMA study used standardized regional regression equations detailed in USGS publication 90-4197 *Regionalization of Flood Discharges for Rural, Unregulated Streams in New York, Excluding Long Island* (USGS, 1991). This regression analysis uses parameters such as mean annual precipitation and several watershed characteristics to estimate flow frequencies. FEMA applied these discharges in a backwater analysis of Steele Creek, compared the resulting water surface elevations with historical elevations, and checked for reasonableness. The results were published in the FIS, and the resulting mapping was published as the effective Flood Insurance Rate Map (FIRM) for Herkimer County.

Estimated peak discharges for various frequency events were calculated by MMI using *StreamStats* and were then compared to peak discharges reported in the FEMA FIS. Table 2 lists peak discharges on Steele Creek as reported in FEMA's FIS. Table 3 lists peak discharges on Steele Creek at several tributaries, as calculated using *StreamStats*.

There are substantial discrepancies between the peak discharges reported by FEMA and those determined using *StreamStats*. Both sets of flow data were used in a preliminary hydraulic model to determine which set would better represent known flooding conditions. The results of this comparison led to the conclusion that the larger flows produced by *StreamStats* appear to reflect conditions during the June 2013 flooding more accurately than the lower flows estimated by FEMA. *StreamStats* flows were then generated at relevant locations in the model and at confluences with larger tributaries. Table 4 reflects the flows that were used in the Hydrologic Engineering Center – River Analysis System (HEC-RAS) model.

TABLE 2
Steele Creek FEMA Peak Discharges

Location	Drainage Area (sq. mi.)	10-Yr Flow	50-Yr Flow	100-Yr Flow	500-Yr Flow
		FEMA Peak Discharges			
Just upstream tributaries at approx. Station 26200	3.5	250	350	400	510
Just upstream tributaries at approx. Station 1980	5.8	522	770	880	1,150
Just upstream tributaries at approx. Station 12600	8.5	790	1,175	1,350	1,760
Approximately 1 mile upstream of Remington Road	13.4	350	460	510	620
At confluence with Mohawk River	26.7	1,980	2,900	3,310	4,280

TABLE 3
Steele Creek *StreamStats* Peak Discharges

Location	Drainage Area (sq. mi.)	10-Yr Flow	50-Yr Flow	100-Yr Flow	500-Yr Flow
		StreamStats Peak Discharges			
MMI Station 263+00 (1 mile u/s Remington Road)	16.6	1,770	2,600	3,010	3,990
MMI Station 198+00	18.8	1,950	2,850	3,300	4,360
MMI Station 126+00	19.2	1,950	2,860	3,300	4,360
MMI Station 54+00	27.0	2,600	3,790	4,380	5,770
Mohawk confluence	27.3	2,630	3,840	4,430	5,840

TABLE 4
Final Hydrology for HEC-RAS Modeling of Steele Creek

Station	Bankfull Flow	10-Yr Flow	50-Yr Flow	100-Yr Flow	500-Yr Flow
		StreamStats Peak Discharges			
128+85	568	1,950	2,860	3,300	4,360
113+00	688	2,390	3,500	4,050	5,340
98+00	742	2,520	3,680	4,260	5,610
63+00	746	2,540	3,710	4,290	5,640

2.7 Infrastructure

Bridge spans and heights were measured as part of the field inspection. Table 5 summarizes the bridge measurements collected during field inspection. For the purpose of comparison, estimated bankfull widths at each structure are also included. The data indicate that most of the bridges are not wide enough to span the bankfull width of Steele Creek.

TABLE 5
Summary of Stream Crossing Data

Roadway Crossing	BIN	Station	Width (ft)	Height (ft)	Bankfull Width (ft)
Route 51 #1 U/S Jerusalem Hill Rd	---	352+50	11.5	7.5	35.5
Route 51 #2 U/S Jerusalem Hill Rd	---	347+50	10.0	8.0	35.5
Route 51 D/S Jerusalem Hill Rd	---	307+50	66.5	6.8	42.3
Private Driveway off Route 51	---	306+00	25.5	5.5-7.0	29.1
Private Driveway off Route 51	---	267+00	30.0	3.4	29.1
Route 51 Crossing 4	000000001069850	263+50	21.5	7.2	37.1
Route 51 Crossing 3	000000001069820	243+00	32.0	8.0	48.3
Route 51 Crossing 2	000000001069830	224+00	24.0	8.0	50.3
Route 51 - South of Remington Rd	000000001069840	207+00	18.0	8.5	50.3
Spinnerville Gulf Road North	000000003307680	112+50	40.5	7.0	56.2
Clapsaddle Farm Road	---	89+00	42.0	10.0-10.8	58.6
Richfield Street	000000002266840	83+00	44.8	1.3-9.0	58.7
Philip Street	000000002266850	69+50	42.0	2.5-6.9	58.7
Otsego Street	000000001026490	56+00	27.0	6.8	59.4
Third Street	000000002266860	42+50	31.0	5.2-6.2	59.4
Second Street	000000002266870	37+50	76.0	7.4	59.4
West Main Street	000000001002720	25+00	51.0	7.0-7.5	59.5
Railroad Bridge	---	6+00	---	---	59.5
Route 5 South	000000001073640	3+00	121.0	2.5-16.0	59.6

Flood profiles published in the FEMA FIS were evaluated to determine which bridges on Steele Creek are acting as hydraulic constrictions during large flood events and which bridges overtop during these events. According to the FEMA profiles, many of the bridge crossings act as significant hydraulic constrictions and are overtopped during 10-year or greater flood events.

3.0 FLOODING CHARACTERISTICS

3.1 Flooding History in Steele Creek

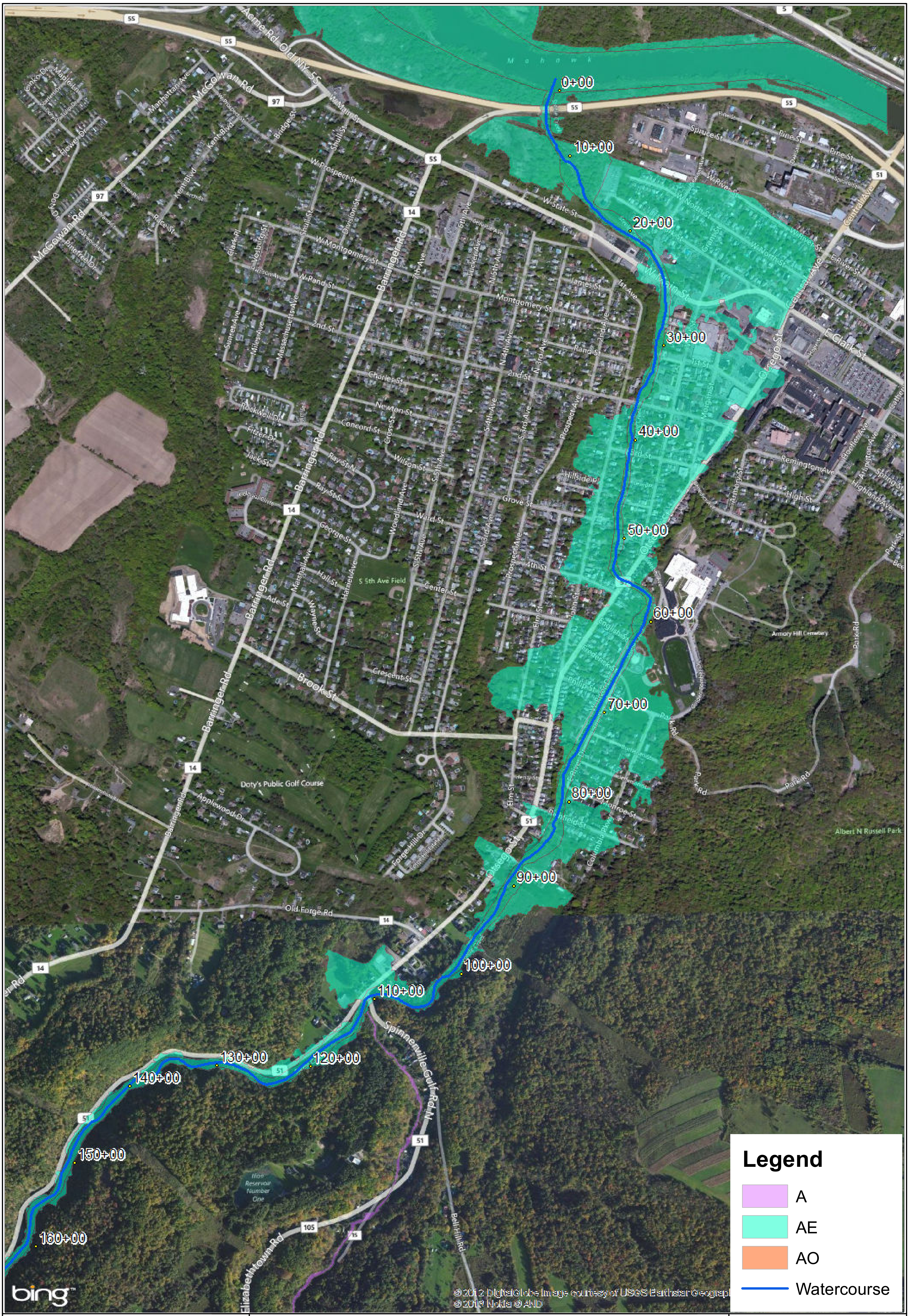
The most severe flooding on Steele Creek has occurred at Spinnerville Gulf Road; along the creek between Clapsaddle Farm Road and the Otsego Street bridge; and from Otsego Street downstream to West Main Street. Severe flood-related damages have occurred at all of these locations.

The FEMA flood insurance study for Herkimer County reports that heavy rainfall on Steele Creek, especially in the spring, combined with snowmelt, frequently causes high water and local flooding in the village of Ilion. Downstream ice jams, severe thunderstorms, and tropical storms have also caused flooding problems. According to FEMA, the greatest known flood on Steele Creek occurred on June 11, 1922. During this event, 18 percent of the village of Ilion was inundated by floodwaters, and the Philips Street bridge and Whitney Steel bridge were destroyed. FEMA also reports flooding on the following dates:

- On March 16, 1989, an ice jam event occurred on Steele Creek in the village of Ilion at one of the old arch-styled bridges.
- On January 19, 1997, an ice jam occurred at the Main Street bridge, causing residents to be concerned with potential damage to the gas line crossing.
- On January 24, 2003, an ice jam formed at Philip Street bridge, causing water to back up into the basements of surrounding homes.

FEMA flood insurance maps are available for Steele Creek (Figure 5). The maps highlight the extensive nature of flooding that occurs in the village of Ilion during a 100-year frequency flood event. The FEMA flood maps indicate that the most extensive area of flooding occurs from upstream of Clapsaddle Farm Road (STA 89+00), downstream to the outlet of Steele Creek (STA 0+00), with an extensive area of downtown Ilion inundated by floodwaters.

In mid to late June and early July of 2013, a severe precipitation system caused excessive flow rates and flooding in a number of communities in the greater Utica region, including in the Steele Creek basin. Because rainfall across the region was highly varied and rainfall information is limited, it is not possible to determine exact rainfall amounts within the Steele Creek basin.



SOURCE(S):	Figure 5: Steele Creek FEMA Floodzones	Location: Herkimer County, New York
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Historic records on the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) Advanced Hydrologic Prediction Service website indicate that the village of Ilion area received between 10 and 15 inches of rainfall in the month of June and an additional 5 to 8 inches in July 2013. Much of this rainfall occurred over several storm events that dropped between 3.5 and 4.5 inches of rain between June 11 and June 14; 5.5 to 8.5 inches between June 24 and June 28; and 1.5 to 2.0 inches on July 2. In between these more severe rain events were a number of smaller rain showers that dropped trace amounts of precipitation, preventing soils from drying out between the larger rain events.

According to community officials, during the June 2013 flood event, large amounts of debris were conveyed down Steele Creek from higher in the watershed and deposited within the channel along the lower part of the creek. Flooding and damage occurred along the left side of the channel on English Street (STA 69+50). The bridge at Otsego Street (STA 56+00) was heavily damaged; utility lines running across the bridge were broken; and the headwall was destroyed. Water backed up behind the Otsego Street bridge, then overtopped and ran down Otsego Street. The 3rd Street bridge (STA 42+50) was also damaged (this bridge was completely destroyed in a 2006 flood). Flooding also occurred in the vicinity of the West Main Street bridge (STA 25+00).

3.2 Post-Flood Community Response

Following the heavy flooding in June 2013 along Steele Creek and other regional streams and creeks, the NYS Department of Transportation, the town of German Flatts and the village of Ilion implemented numerous repairs. Private property owners throughout the town and village attempted repairs to individual sections of stream bank as well.

According to municipal officials, large reaches of Steele Creek were stabilized after the June 2013 flood. The channel downstream of Spinnerville Gulf Road bridge (STA 112+50) was lined with stacked rock walls. Post-flood repairs were performed on the Otsego Street bridge (STA 56+00), and dredging was performed starting at the bridge and extending upstream. Sediment that was dredged from the channel was sidecast onto the banks. Exposed clay was noted along this reach, indicating that dredging may have extended beyond the natural creek bed.

The channel in the vicinity of the dam at STA 69+50 reportedly overtopped during the June 2013 flooding. During field investigations in the fall of 2013 it appeared as though the concrete walls had been reconstructed to a higher elevation on the left creek bank, and stacked stone and riprap were used to armor the right bank.

In a project unrelated to the 2013 storm, an existing bridge crossing on Philip Street was removed, and a new structure was constructed approximately 250 feet downstream on Frederick Street. In addition, a parking area was constructed on the eastern bank of the creek. The Otsego Street bridge was repaired as a result of the 2013 storm event.

Minor dredging and bank stabilization were also completed downstream and upstream of Richfield Street (STA 83+00) along Steele Creek. Significant repairs were made to the channel where Clapsaddle Creek joins Steele Creek at STA 98+00 as a result of a large gas transmission line being exposed during the 2013 storm.

The reach downstream of Spinnerville Gulf Road experienced some minor bank erosion, and a large bank failure occurred around the outside of a bend in a largely wooded area between STA 108+00 and STA 106+00. This bank failure has been treated with a stacked stone wall; bendway weirs were installed; and additional stacked wall was placed in other intermittent reaches along the banks of the creek. These stabilization measures were implemented in response to the June 2013 flooding.

The bridge at Spinnerville Gulf Road reportedly overtopped during the June 2013 event. Sediment accumulation around the bridge was dredged after the storm, and the banks in the vicinity were stabilized with stacked stone and planted with vegetation.

3.3 Flood Mitigation Analysis

Hydraulic analysis of Steele Creek was conducted using the HEC-RAS program. The HEC-RAS computer program (*River Analysis System*) was written by the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC), considered to be the industry standard for riverine flood analysis. The model is used to compute water surface profiles for one-dimensional, steady-state, or time-varied flow. The system can accommodate a full network of channels, a dendritic system, or a single river reach. HEC-RAS is capable of modeling water surface profiles under subcritical, supercritical, and mixed-flow conditions.

Water surface profiles are computed from one cross section to the next by solving the one-dimensional energy equation with an iterative procedure called the standard step method. Energy losses are evaluated by friction (Manning's Equation) and the contraction/expansion of flow through the channel. The momentum equation is used in situations where the water surface profile is rapidly varied, such as hydraulic jumps, mixed-flow regime calculations, hydraulics of dams and bridges, and evaluating profiles at a river confluence.

Hydraulic modeling that was originally generated by FEMA as part of its 2004 study of Steele Creek was obtained and used as a starting point for the current analysis. It can be assumed that conditions have changed since the date of this study and, for that reason, updated cross sections were surveyed as part of the subject analysis. The updated survey information was incorporated into the hydraulic model in order to better characterize and understand modern flooding risks and causes.

The survey effort included the wetted area (within bankfull elevation) of 17 stream cross sections, plus the survey of five bridges/culverts and one grade control structure currently acting as a run-of-river dam. This data was combined with countywide light detection and ranging (LiDAR) data provided by the NYSDEC to develop sufficient model geometry such that existing conditions flooding up to and including the 100-year recurrence interval could be modeled.

The model of existing conditions was then used to hydraulically model certain alternatives, described further in the report sections that follow. Model input and output files have been uploaded onto the NYSDOT ProjectWise site and delivered electronically to NYSDEC.

3.4 High-Risk Area #1 – Spinnerville Gulf Confluence (STA 95+00 to STA 117+00)

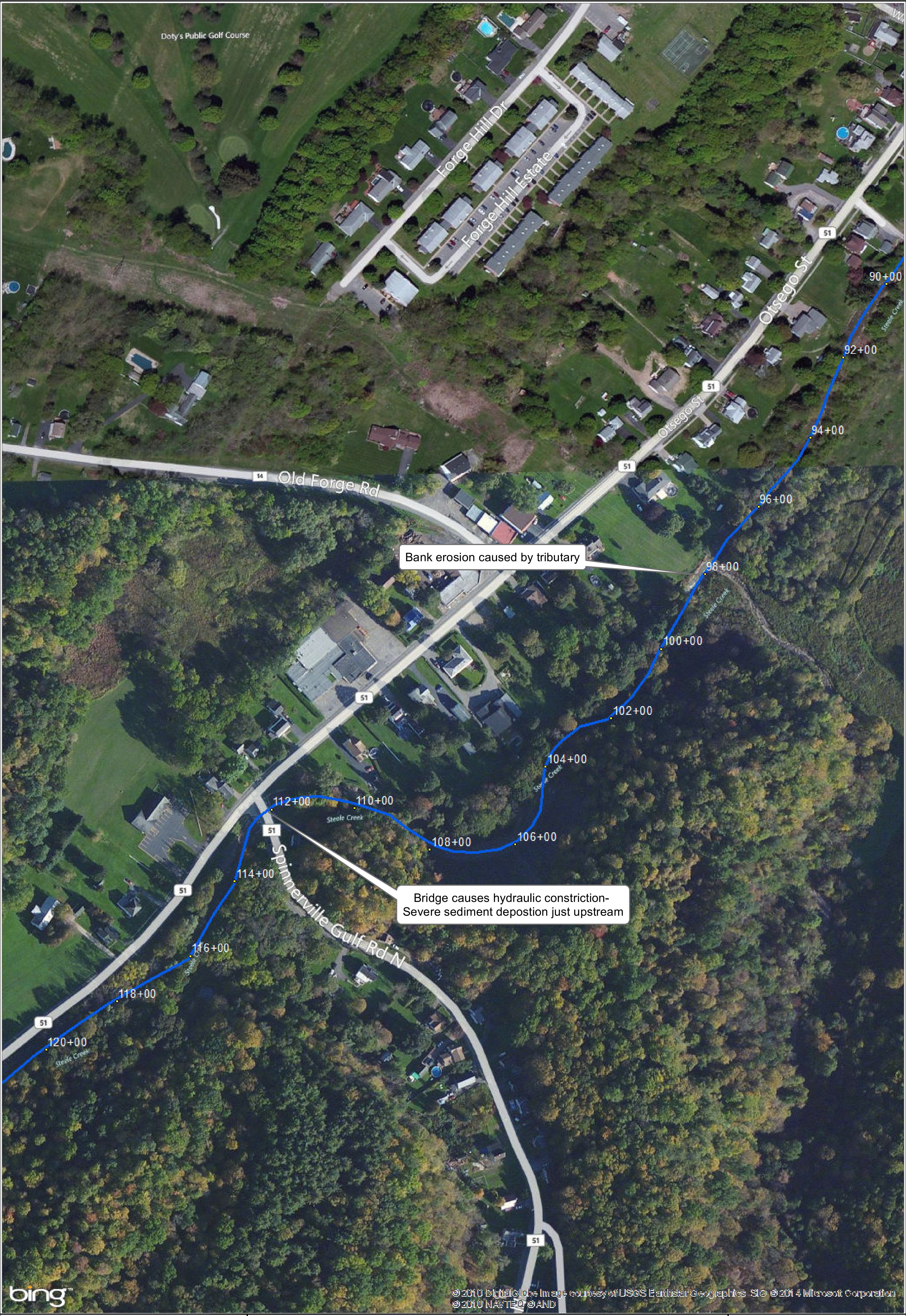
Figure 6 is a location plan of High Risk Area #1, which includes the section of Steele Creek from the outlet of Ilion Gorge upstream of the Spinnerville Gulf Road crossing (STA 117+00) to 300 feet downstream of a gas and high voltage electricity crossing (STA 95+00). This reach is subject to sediment aggradation. The most severe sediment deposition zone is between STA 116+00 and STA 113+00, just upstream of the Spinnerville Gulf Road bridge. This bridge is shown as a minor hydraulic constriction on the FEMA flood profile and FIRM. Downstream of STA 108+00, discontinuous stacked stone wall and bank stabilization efforts have been placed since the June 2013 flood event.

Hydraulic modeling indicates that the Spinnerville Gulf Road bridge does not cause the channel to overtop during a 100-year flood event, but it does overtop during a 500-year event. Based on the model of current conditions, removal or replacement of the bridge would not provide appreciable benefit to flooding in this reach. This model may not reflect the conditions of the channel at the time of the June 2013 floods, which may have had appreciably more sediment deposition at the time. A partially clogged bridge opening will cause floodwaters to overtop the bridge at lower flows.

Spinnerville Gulf Road crosses Steele Creek as the creek exits the steep and confined Ilion Gorge. The gorge walls wash broken pieces of bedrock into the channel and confine flows within a deep channel with high shear strength. As Steele Creek flows through the gorge, it carries the sediment load with it until it reaches the relatively flatter, wider area in the vicinity of Spinnerville Gulf Road bridge. The natural topography of the creek and floodplain indicate that this flat area historically acted as a sediment delta for bedload sediments originating in the gorge. The tributary entering Steele Creek in this area also contributes a high sediment load.

Alternative 1-1: Develop and Implement Sediment Management Plan

Dredging (specifically lowering) Steele Creek was evaluated to determine its merit to mitigate flooding. Such action will further isolate the stream from its natural floodplain, disrupt sediment transport, potentially cause upstream bank/channel scour, and encourage additional downstream sediment deposition. Improperly dredged stream channels often show signs of severe instability, which can cause larger problems after the work is complete. Such a condition is likely to exacerbate flooding on a long-term basis.



SOURCE(S):	Figure 6: Steele Creek High Risk Area #1		Location: Herkimer County, New York
	N — NYDOT: Emergency Transportation Infrastructure Recovery	Map By: CMP MMI#: 5231-01 MXD: Y:\5231-01\GIS\Maps\High Risk Areas\Steele Creek High Risk #1.mxd 1st Version: 01/06/2014 Revision: 3/13/2014 Scale: 1 in = 200 ft	MILONE & MACBROOM 99 Realty Drive Cheshire, CT 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com

The need for sediment excavation in Steele Creek can be reduced by decreasing the sediment load at its sources (i.e., by repairing bank failures and headcuts and reducing erosion) and by improving sediment transport. Sediments will continue to be transported downstream regardless of what actions are taken to control sediments in the upper reaches. These are prone to depositing in the lower reaches, thus reducing channel capacity and contributing to flooding in the village of Ilion.

Dredging is often the first response to sediment deposition and clogging of the stream channel or bridge openings; however, over-widening or over-deepening through dredging can initiate headcutting, foster poor sediment transport, result in low habitat quality, and not necessarily provide significant flood mitigation. Dredging can further isolate a stream from its natural floodplain, disrupt sediment transport, expose erodible sediments, cause upstream bank/channel scour, and encourage additional downstream sediment deposition. Improperly dredged stream channels often show signs of severe instability, which can cause larger problems after the work is complete. Such a condition is likely to exacerbate flooding on a long-term basis.

A sediment management program involves the development of standards to delineate how, when, and to what dimensions sediment excavation should be performed. It will also require the proper regulatory approval, as well as budgetary considerations to allow the work to be funded on an ongoing or as-needed basis as prescribed by the standards to be developed.

Conditions in which active sediment management should be considered include:

- situations where the channel is confined, without space in which to laterally migrate
- for the purpose of infrastructure protection
- at bridge openings where hydraulic capacity has been compromised
- in reaches with low habitat value

In cases where dredging of the stream channel is necessary, a methodology should be developed that would allow for proper channel sizing and slope. The following guidelines are provided:

1. Maintain the original channel slope and do not overly deepen or widen the channel. Excavation should not extend beyond the channel's estimated bankfull width unless it is to match an even wider natural channel. Estimated bankfull widths on Steele Creek are provided in Table 1 of this report and range from 51.0 feet at STA 116+00 at Spinnerville Gulf Road, to 59.5 feet at STA 25+50 at West Main Street.

2. Sediment management should be limited in volume to either a single flood's deposition or to the watershed's annual sediment yield in order to preclude downstream bed degradation from lack of sediment. Annual sediment yields vary, but one approach is to use a regional average of 50 cubic yards per square mile per

year unless a detailed study is made. The estimated annual sediment yield of Steele Creek is 1,365 cubic yards.

3. Excavation of fine-grain sediment releases turbidity. Best available practices should be followed to control sedimentation and erosion.

4. Sediment excavation requires regulatory permits. Prior to initiation of any in-stream activities, NYSDEC should be contacted, and appropriate local, state, and federal permitting should be obtained.

5. Disposal of excavated sediments should always occur outside of the floodplain. If such materials are placed on the adjacent bank, they will be vulnerable to remobilization and redeposition during the next large storm event.

6. No sediment excavation should be undertaken in areas where rare or endangered species are located.

Recommendation

Because of the steepness of the gorge in this reach of Steele Creek, no sufficiently open areas have been identified for potential sediment storage. The channel reach directly upstream of Spinnerville Gulf Road should be assessed as a possible sediment management area, for regular and responsible removal of accumulated sediment. This would help to maintain the hydraulic conveyance needed in the channel and the Spinnerville Gulf Road bridge crossing to reduce the occurrence of bank overtopping during flood flows. Sediment excavation will likely be required through this reach on a periodic basis and should be accomplished using the guidelines provided.

3.5 High-Risk Area #2 – The Falls (STA 56+00 to STA 91+00)

Figure 7 is a location plan of High Risk Area #2. This area extends from STA 91+00 downstream to STA 56+00 and includes the Clapsaddle Farm Road bridge (STA 89+00, indicated on the FEMA flood profile as Whitney Street), the Richfield Street bridge (STA 82+75), the Frederick Street bridge (STA 67+00), the dam at STA 64+75 (known locally as "The Falls"), and the Otsego Street bridge (STA 56+00). The channel upstream of the dam is lined on the right bank by East River Drive and on the left bank by West River Drive. These two roads closely confine the channel, leaving no overbank area during flood events.

According to the FIRM and community officials, this area experiences extensive flooding. The flood profiles indicate that the Clapsaddle Farm Road bridge and the Otsego Street bridge are acting as severe hydraulic restrictions. The dam at STA 64+75 is also causing an increase in water surface elevations upstream of the dam.

SOURCE(S):	Figure 7: Steele Creek High Risk Area #2	Location: Herkimer County, New York

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NYDOT: Emergency Transportation Infrastructure Recovery

Map By: CMP
MMI#: 5231-01
MXD: Y:\5231-01\GIS\Maps\High Risk Areas\Steele Creek High Risk #2.mxd
1st Version: 01/06/2014
Revision: 4/11/2014
Scale: 1 in = 250 ft

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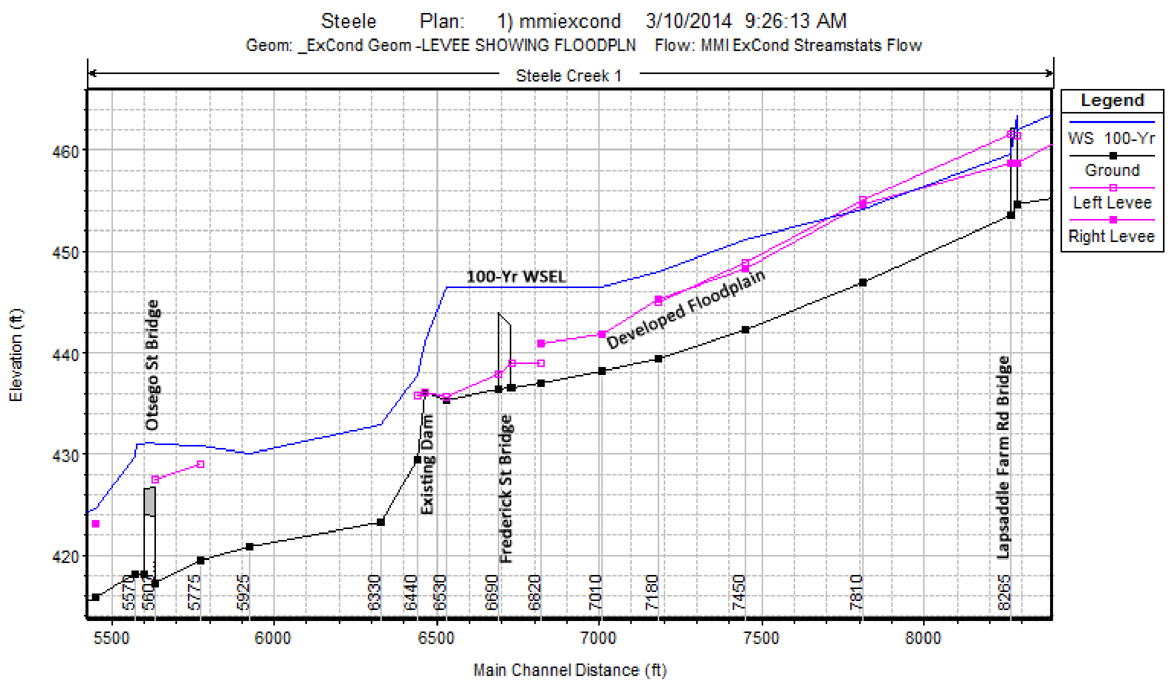
The concrete run-of-river dam is approximately 13 feet high and 42 feet long. It does not appear to serve any modern day purpose. The dam has accumulated sediment behind it to the elevation of the crest, which has raised the bed of the upstream channel closer to that of the adjacent floodplain. Figure 8 shows a profile of Steele Creek near the dam and illustrates how the aggraded channel upstream has almost reached the elevation of the adjacent floodplain. This makes it very easy for flood flows to overtop the banks and flow into the residential areas along the left bank of Steele Creek to the west of the dam. Figure 8 also illustrates how the Otsego Street bridge acts to back up flows.

FIGURE 8
Hydraulic Modeling Results - Steele Creek Profile
STA 55+00 to STA 84+00



Hydraulic modeling indicates that removal of the dam will help to reduce the frequency and severity of flooding but will not eliminate it entirely. Three undersized bridges in the immediate vicinity of the dam overtop under current conditions, exacerbating flooding. The channel through this reach is undersized to convey flood flows due to the close proximity of the roads along both banks as well as historic filling and development in the floodplain.

Alternatives 2-1 through 2-3 were assessed through hydraulic modeling to determine their effectiveness at flood mitigation for this high- risk area of Steele Creek. Because of substantial accumulation of sediment upstream of the dam, its removal would impact a significant amount of upstream channel. As the channel is lowered, the banks will need to be stabilized. Lowering of the channel may also expose bridge footings that were previously buried.

Alternative 2-1: Dam Removal, Bridge Replacement, and Floodplain Restoration

This alternative involves a substantial reworking of this reach of Steele Creek. It includes the following components.

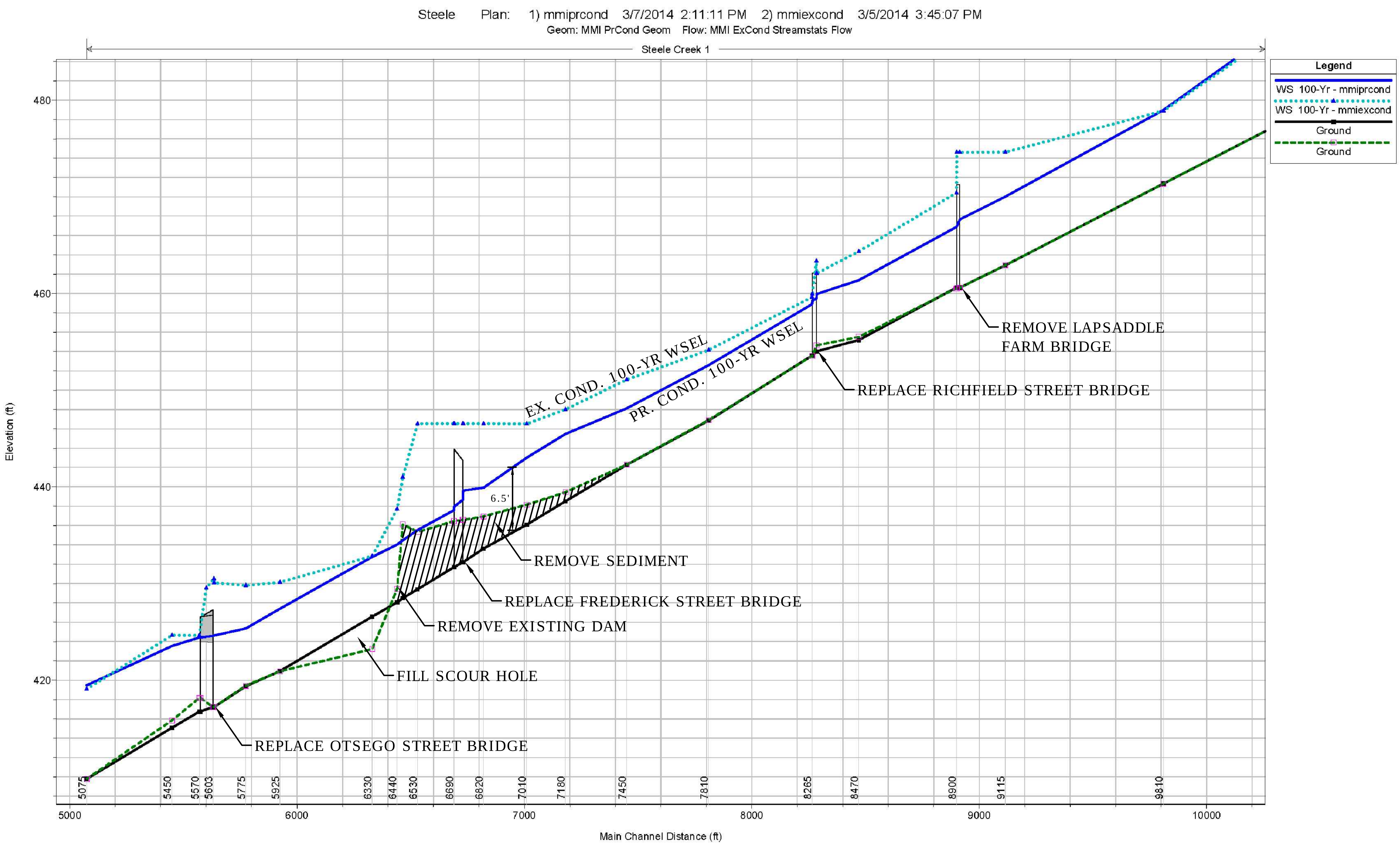
- Remove the severely undersized Clapsaddle Farm Road bridge (STA 89+00) and reroute farm access from Columbia Parkway.
- Replace the undersized Richfield Street bridge (STA 83+00) with a larger span.
- Deepen and widen the channel along 3,500 feet from approximately STA 89+15 downstream to STA 54+50, which includes widening the bankfull channel to approximately 50 feet wide by 2.5 feet deep and creating a floodplain bench to a width of 90 to100 feet, and constructing grade control structures.
- Remove East River Road between STA 79+50 and STA 64+00 and convert Monroe Street, Jefferson Street, and Buchanan Street to cul-de-sacs. This necessitates the purchase and demolition of three homes on the right side of Steele Creek, whose driveways are located on a portion East River Drive that would have to be removed.
- Replace or modify the Frederick Street bridge (STA 67+00) and potentially deepen footings.
- Remove existing 42-foot-long by 13-foot-high concrete dam at STA 64+75.
- Replace the Otsego Street bridge (STA 56+00) with a larger span.

The associated impact quantities are as follows:

- 3,500 linear feet of channel to be widened by 50 feet
- 2,800 linear feet of bank armoring to support roadway
- 1,450 linear feet of channel dredging
- 1 dam removal
- 3 bridge replacements
- 1 bridge removal
- 9 private property acquisitions; at least 15 property impacts

A project of this type is likely to take a long time to fully implement and will be costly considering the large impact to private property and the potential impact to adjacent utilities. However, hydraulic modeling indicates that the proper design and restoration of this overly developed reach of channel could eliminate flooding upstream of Otsego Street for flows up to and including the 500-year flood. This alternative would not address flooding downstream of Otsego Street.

Figure 9 presents a profile of this reach under conditions proposed in Alternative 2-1, including the modeled hydraulic benefits of the improvements.



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REVISIONS

Hydraulic Modeling Analysis- Steele Creek Profile

WATER BASIN ASSESSMENT
AND FLOOD HAZARD MITIGATION ALTERNATIVES

STEELE CREEK
ILION, NEW YORK

JCM	DRM	JCM
DESIGNED	DRAWN	CHECKED

SCALE: N.T.S.

DATE: 3/10/2014

PROJECT NO.: 5231-01

SHEET NO.: **FIG. 9**

Alternative 2-2: Dam Removal and Channel Restoration

A more cost-balanced approach to alternative 2-1 was assessed. This alternative sought to reduce the amount of channel widening, thus reducing the impact to private properties and bridges. It should be noted that this alternative would not provide the same level of flood mitigation as Alternative 2-1 and, if pursued, could be combined with other alternatives such as Alternative 2-3. The proposed alternative includes the following:

- Channel restoration for 3,500 linear feet, from STA 63+30 to STA 68+20, which includes widening the bankfull channel to 50 feet wide by 2.5 feet deep and creating a floodplain bench to a width of 90 to100 feet.
- Replace the Richfield Street bridge (STA 83+00) with a larger span and potentially deeper footings

The associated impact quantities are as follows:

- 500 linear feet of channel to be widened by 50 feet
- 500 linear feet of wall to support roadway
- 1 bridge replacement
- 1 dam removal
- 0 private property acquisitions but at least 2 property impacts

Alternative 2-3: Remove and Replace Undersized Bridges and Floodplain Restoration

Replacement of undersized bridges at Clapsaddle Farm Road (STA 89+00), Richfield Street (STA 83+00), Frederick Street (STA 67+00), and Otsego Street (STA 56+00) will not prevent flooding from occurring through this reach. The undersized channel width and the dam are major contributors to the flooding. However, replacement of the bridges will be necessary in order to accommodate floodplain reclamation, and each bridge replacement will improve hydraulic capacity and reduce upstream flooding.

Modeling indicates that bridges spanning Steele Creek in this reach would have to be widened to the width of the floodplain, or approximately 100 feet in span, in order to accommodate the 500-year flow event or a flow event similar to that experienced in June 2013. Once land acquisitions, utility conflicts, and other design constraints are finalized and the final channel configuration is established, the individual crossings may be value engineered to reduce their span lengths if possible.

Alternative 2-4: Creation of Flood Storage Detention Area

During field investigations, a number of sites within the Steele Creek basin were investigated for their potential use as floodwater detention areas to reduce peak flows. One site was initially identified as potentially being feasible for this purpose. The feasibility of storing floodwater within an area of farmland upstream of Clapsaddle Road, from STA 91+00 upstream to STA 104+00, was further investigated. With excavation of a detention area at this site combined with the construction of a berm to increase storage capacity and protect nearby houses from flooding, the total storage during a 100-year frequency flood event would equal approximately 103,800 cubic yards, or 2.2 percent of the total storm runoff. The goal or "rule of thumb" for a feasible, cost-effective flood detention area is to store at least 10 percent of the runoff generated during the 100-year event. Given the small detention capability at this site, floodwater detention is not considered to be a feasible alternative at this location. Calculations are included in Appendix D.

Recommendations

Dam removal will provide the most significant flood reduction in this reach. However, removal and replacement of undersized bridges would be required to fully mitigate flooding. Alternative 2-1 is recommended as a comprehensive approach to flood mitigation. This would remove the dam and replace the undersized bridges while increasing the size of the channel and removing the accumulated sediment from behind the existing dam. If only limited funding can be obtained, flood mitigation could be staged over time, which is essentially Alternative 2-2 and Alternative 2-3.

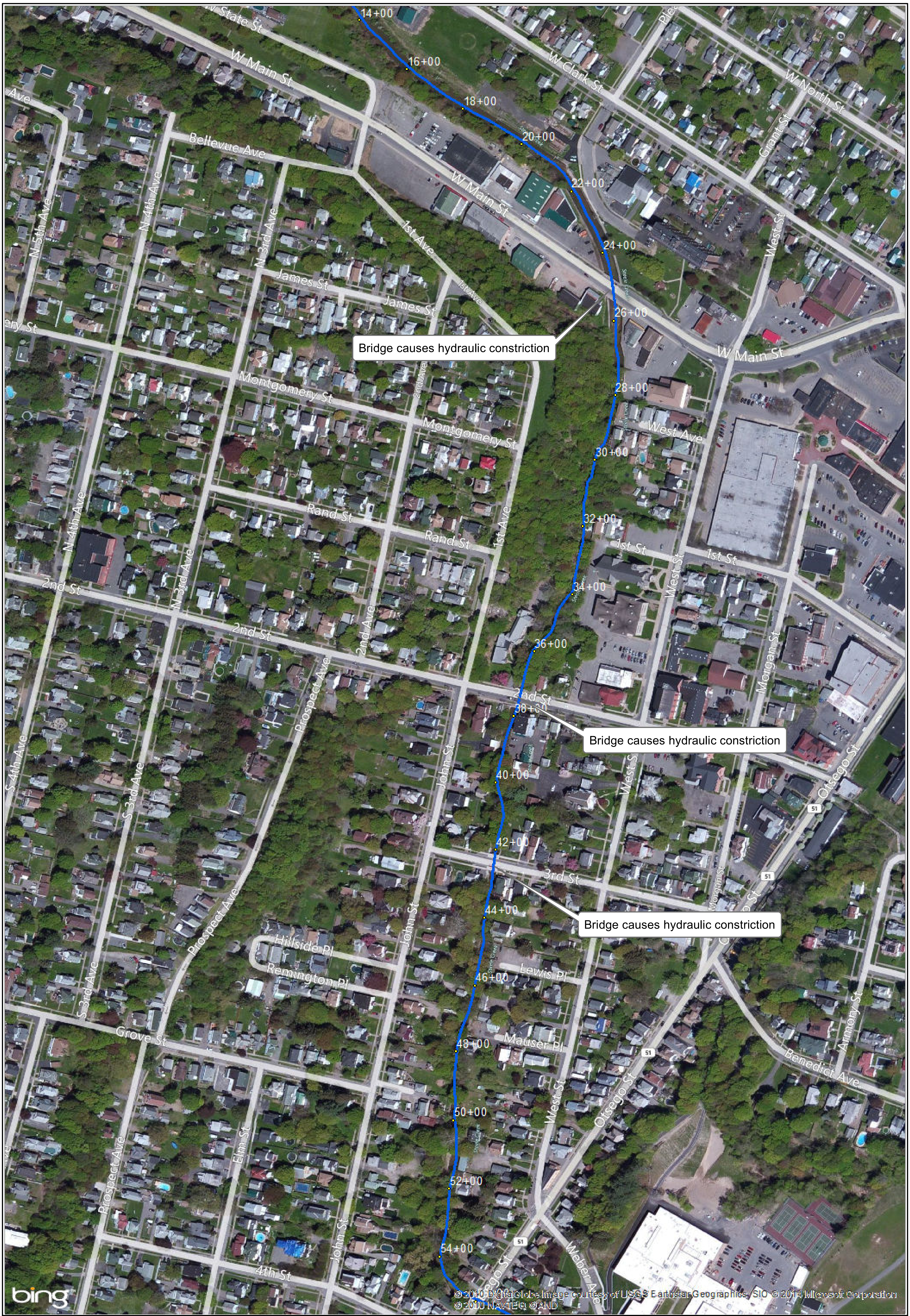
3.6 High-Risk Area #3 – Otsego, First, Second, Third, and West Main Streets (STA 14+00 to STA 56+00)

Figure 10 depicts High Risk Area #3, which extends from below Otsego Street (STA 56+00) to downstream of West Main Street (STA 14+00). FEMA mapping shows extensive flooding throughout this high risk area. Third Street, Second Street, and the Main Street bridges are all shown as hydraulic constrictions.

Assessment of the available FEMA data indicates that the Second and Third Street bridges are among the most severely undersized bridges along Steele Creek. Community officials indicate that the Third Street bridge was replaced as a result of the 2006 storm and its size increased. However, the development constraints on both banks restricted further channel expansion. Field inspection of the channel along this reach indicates that it is too narrow in relation to regional geometry bankfull estimates and also too small to convey flood flows. Its banks are high and steep, and development has been extended to the edge of the banks throughout this reach, reducing the conveyance of the creek. Hydraulic capacity is reduced further by sediment deposition in the reach, and a sediment management plan may be necessary for future deposition in the channel.

Alternative 3-1: Channel Widening with Floodplain Restoration

Hydraulic modeling upstream of this reach indicates that the bankfull channel should be 50 feet in width, and an unobstructed floodplain bench should be approximately 100 feet in width in order to pass 100-year flood flows without overtopping the banks. Widening of 4,200 linear feet of channel to appropriate bankfull dimensions and creation of floodplain benches will be very difficult in this reach due to the dense development on both banks.



SOURCE(S):

Figure 10: Steele Creek High Risk Area #3

Location: Herkimer County, New York

NYDOT: Emergency Transportation Infrastructure Recovery

Map By: CMP
MMI#: 5231-01
MXD: Y:\5231-01\GIS\Maps\High Risk Areas\Steele Creek High Risk #3.mxd
1st Version: 01/06/2014
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Scale: 1 in = 250 ft

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Alternative 3-2: Remove and Replace Undersized Bridges

FEMA modeling in this reach indicates that the bridges at West Main Street, Second Street, and Third Street are all severely undersized. These bridges should be slated for replacement as funding allows and should be assessed individually for proper sizing. These bridges are likely to require at least 100-foot span bridges or greater.

Recommendations

It may be cost prohibitive to expect that the bridges and associated channel widening described in Alternatives 3-1 and 3-2 can be completed at one time, but each of the undersized bridges should be considered for replacement as funding allows. The associated channel widening and floodplain restoration may be difficult due to the number of private property impacts, but a long-term implementation plan is recommended to complete this work.

3.7 Individual Property-Based Risk Areas

Alternative 4-1: Strategic Acquisition of Floodprone Properties

In areas along Steele Creek where dwellings have suffered repeated losses due to flooding, property acquisition is a potentially viable mitigation alternative either through a FEMA buyout program or governmental buyout. Such properties can be converted to passive, non-intensive land uses such as streamside parks, picnic areas, fishing access sites or wildlife observation areas, or simply left as unimproved open space.

In instances where certain properties may qualify, property acquisitions may be funded by FEMA under three grant programs: the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM), and Flood Mitigation Assistance (FMA). The PDM Program was authorized by Part 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act) and provides funds for hazard mitigation planning and mitigation projects. The HMGP is authorized under Section 404 of the Stafford Act and provides grants to implement hazard mitigation measures after a major disaster declaration. 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 FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 with the goal of reducing or eliminating claims under the National Flood Insurance Program (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 NFIP provides the funding for the FMA program. The PDM and 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. FEMA is the entity that dispenses funds for all three programs.

Historically, acquisitions and elevations of structures have been eligible for funding only when the project is found to be cost effective using FEMA's benefit-cost analysis (BCA) program. The BCA utilizes data from the FIS or previous flood damage claims to calculate the benefit-cost ratio (BCR) associated with the acquisition. The project cost (acquisition fees plus site restoration) must be known to determine the BCR. While this process has proved effective for funding many property acquisitions nationwide, there were many instances where BCRs above 1.0 were not computed due to site-specific challenges or data gaps.

The Biggert-Waters Flood Insurance Reform Act of 2012 made several changes to the mitigation programs, and the new Hazard Mitigation Assistance (HMA) guidance was released in July 2013. One potentially important change to the PDM, HMGP, and FMA programs is that green open space and riparian area benefits can now be included in the project BCR once the project BCR reaches 0.75 or greater. This is one potential method of bridging the gap between a BCR of 0.75 and a BCR of 1.0.

On August 15, 2013, FEMA issued new guidance for acquisitions and elevations of structures within Special Flood Hazard Areas (SFHAs). According to the guidance, acquisitions with a project cost lower than $276,000 and elevations with a project cost lower than $175,000 may be considered *automatically cost-effective for structures in SFHAs*. Although this is a new interpretation of cost effectiveness, it could mean that acquisitions and elevations may be more easily funded without consideration of the BCA.

Once a structure has been acquired and demolished, the property must remain as open space. The intent of the mitigation programs is that structures will not be built in the open space although passive recreation is permitted. To offset the loss of the structure and its occupant, the community should strive to facilitate relocation nearby in areas outside of the floodplain.

<u>Alternative 4-2: Flood Protection Measures of Individual Properties</u>

Potential measures for property protection include the following:

<u>Elevation of the structure.</u> 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 above the 1 percent annual chance flood level. 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.

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

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

Wet floodproofing of the structure to allow floodwaters to pass through the lower area of the structure unimpeded. Wet floodproofing refers to intentionally letting floodwater into a building to equalize interior and exterior water pressures. Wet floodproofing should only be used as a last resort. If considered, furniture and electrical appliances should be moved away or elevated above the 1 percent annual chance flood elevation.

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

- Relocate valuable belongings above the 1 percent annual chance flood elevation to reduce the amount of damage caused during a flood event.
- Relocate or elevate water heaters, heating systems, washers, and dryers to a higher floor or to at least 12 inches above the high water mark (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 to at least 12 inches above the high water mark.

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

Recommendations

Alternatives 4-1 and 4-2 are recommended as flood hazard mitigation solutions in areas where repeated flooding has occurred.

4.0 RECOMMENDATIONS

1. *Adopt Sediment Management Standards* – Large volumes of coarse-grained sediments will continue to be transported into Steele Creek during high flow events regardless of what actions are taken to control sediments in the upper reaches and tributaries. These sediments will be deposited in the lower reaches, reducing channel capacity and contributing to flooding. When excavation of depositional areas is necessary, it should be undertaken in a manner that maintains channel stability, avoiding over-widening and/or over-deepening the channel. Development of sediment management standards is recommended to provide guidance to contractors and local municipal and county public works departments on how to maintain proper channel sizing and slope as well as the application of best practices.

2. *Remove "The Falls" Existing Concrete Dam (STA 64+75)* – Removal of the existing dam will provide the most significant flood reduction in the reach of channel immediately surrounding it; however, removal and replacement of undersized bridges in the area will be important as well. If funding allows, a full dam removal should be pursued, which would involve the removal of aggraded sediment and the restoration of the channel and floodplain to pre-dam conditions. Restoration of the channel would involve the removal of sediment up to 1,450 linear feet upstream, which may impact bridge footings and bank stability.

   A more minimalistic dam removal may still provide a significant reduction in flooding, but a detailed assessment of the dam must be performed before the true costs and benefits can be accurately assessed. Impacts to private properties, upstream and downstream bridges, public infrastructure, and utilities all must be assessed in detail. Therefore, it is recommended that a dam removal assessment be performed.

3. *Remove and Replace Undersized Bridges at Clapsaddle Farm Road (STA 89+00), Richfield Street (STA 83+00), Frederick Street (STA 67+00), and Otsego Street (STA 56+00)* – Replacement of these undersized bridges is recommended in combination with floodplain restoration. The undersized channel width and the dam are both major contributors to the flooding as well. Replacement of the bridges will be necessary in order to accommodate floodplain reclamation.

4. *Widen Undersized Channel and Restore Floodplain* – Deepen and widen the channel along 3,500 feet from approximately STA 89+15 downstream to STA 54+50, which includes widening the bankfull channel to approximately 50 feet wide by 2.5 feet deep and creating a floodplain bench to a width of 90 to100 feet, and constructing grade control structures.

5. *Remove East River Road between STA 79+50 and STA 64+00 and Convert Monroe Street, Jefferson Street, and Buchanan Street to Cul-de-sacs* – Implementation of this recommendation will necessitate the purchase and demolition of three homes

on the right side of Steele Creek, whose driveways are located on a portion East River Drive that would have to be removed.

6. *Replace Undersized Bridges at Third, Second, and West Main Third Street (STA 42+50, 37+50, and 25+00) and Restore Channel and Floodplain* – These bridges should be slated for replacement as funding allows and should be assessed individually for proper sizing. They are likely to require at least a 100-foot span. Approximately 4,200 linear feet of channel is recommended for restoration, recognizing that this will likely require a long implementation timeframe. The bankfull channel should be 50 feet in width, and an unobstructed floodplain bench should be approximately 100 feet in width in order to pass 100-year flood flows without overtopping the banks.

7. *Monitor Minor Bank Failures and Erosion* – Several areas of eroding banks, minor bank failures, and slumping hill slopes were observed along Steele Creek. These are of low to moderate severity, appear to be relatively stable, and at the time of the field visits were not contributing a large amount of sediment to the channel. It is recommended that these sites be monitored periodically and stabilized as necessary.

8. *Evaluate Floodplain Regulations* – A critical evaluation of existing floodplain law and policies should be undertaken to evaluate the effectiveness of current practices and requirements. Identification of a floodplain coordinator and development of a detailed site plan review process for all proposed development within the floodplain would provide a mechanism to quantify floodplain impacts and ascertain appropriate mitigation measures.

9. *Install and Monitor a Stream Gauge* – There is currently no stream gauge on Steele Creek, making statistical analysis difficult. Installation of a permanent stream gauge is recommended.

10. *Develop Design Standards* – There is currently no requirement to design stream crossings to certain capacity standards. For critical crossings such as major roadways or crossings that provide sole ingress/egress, design to the 50- or 100-year storm event may be appropriate. Less critical crossings in flat areas may be sufficient to pass only the 10-year event. Crossings should always be designed in a manner that does not cause flooding. When a structure that is damaged or destroyed is replaced with a structure of the same size, type, and design, it is reasonable to expect that the new structure will be at risk for future damage as well. Development of design standards is recommended for all new and replacement structures.

11. *Acquisition of Floodprone Properties* – Undertaking flood mitigation alternatives that reduce the extent and severity of flooding is generally preferable to property acquisition. However, it is recognized that flood mitigation initiatives can be costly and may take years or even decades to implement. Where properties are located

within the FEMA designated flood zone and are repeatedly subject to flooding damages, strategic acquisition, either through a FEMA buyout or other governmental programs, may be a viable alternative. There are a number of grant programs that make funding available for property acquisition. Such properties could be converted to passive, non-intensive land uses.

12. *Protect Individual Properties* – A variety of measures are available to protect existing public and private properties from flood damage, including elevation of structures, construction of barriers, floodwalls and earthen berms, dry or wet floodproofing, and utility modifications within the structure. 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.

The above recommendations are graphically depicted on the following pages. Table 6 provides an estimated cost range for key recommendations.

TABLE 6
Cost Range of Recommended Actions

	Approximate Cost Range				
Steele Creek Recommendations	< $100k	$100k-$500k	$500k-$1M	$1M-$5M	>$5M
Removal of "The Falls" Existing Concrete Dam			X		
Removal and Replacement of Undersized Bridges					X
Widen Undersized Channel and Restore Floodplain					X
Install and monitor a Stream Gauge	X				

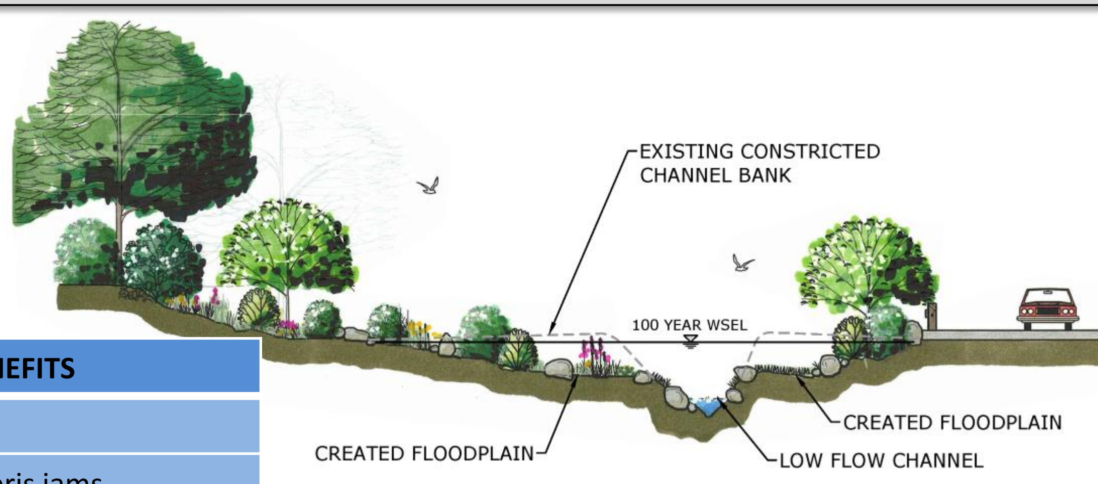
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES
STEELE CREEK, HERKIMER COUNTY, NEW YORK

High-Risk Area #1 – Spinnerville Gulf Confluence

Site Description: From the end of the Ilion Gorge upstream of Spinnerville Gulf Road (STA 117+00) to 300 feet downstream of a gas and high voltage electricity crossing (STA 95+00), sediment aggradation reduces channel capacity, which has caused overtopping and flooded a local veterinarian's office.

Recommendations:

- Channel needs to be adequately sized to convey a bankfull width of 50 feet, and an adequate floodplain bench should be provided, where possible.
- Sediment aggradation causing water to overtop the banks may have to be periodically removed. A sediment management plan should be developed and implemented.



TYPICAL COMPOUND CHANNEL

	BENEFITS
✓	Improved safety
✓	Reduction in debris jams
✓	Improved hydraulic capacity
✓	Reduced flood hazard
✓	Improved ecological connectivity

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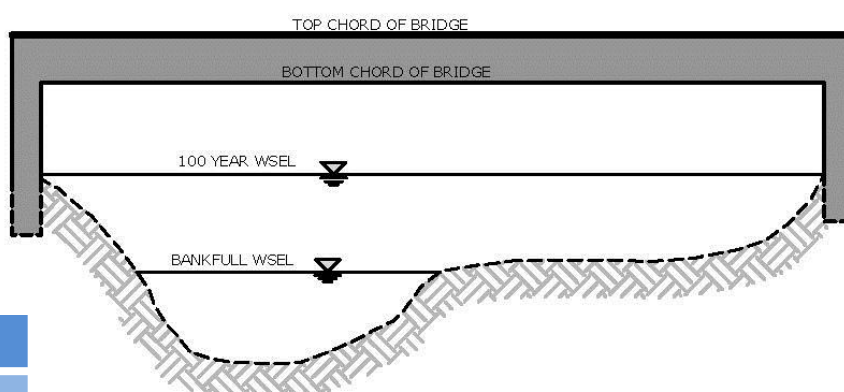
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES
STEELE CREEK, HERKIMER COUNTY, NEW YORK

High-Risk Area #2 – Undersized Bridge Crossings and "The Falls"

Site Description: Beginning upstream of Lapsaddle Farm Road bridge (STA 91+00) to the Otsego Street bridge (STA 56+00), several undersized bridges and an existing dam at STA 64+75 known as "The Falls" cause flooding in the area. Bridges in this reach include Richfield Street Bridge (STA 82+75) and Frederick Street Bridge (STA 67+00).

Recommendations:

- Replace undersized bridge crossings that act as hydraulic constrictions and replace with larger spans (if appropriate).
- Remove existing concrete dam.
- Widen channel to minimum bankfull dimensions and create floodplain bench.



TYPICAL UNCONSTRAINED BRIDGE CROSSING

	BENEFITS
	Improved safety
	Reduction in debris jams
	Improved hydraulic capacity
	Reduced flood hazard
	Improved ecological connectivity

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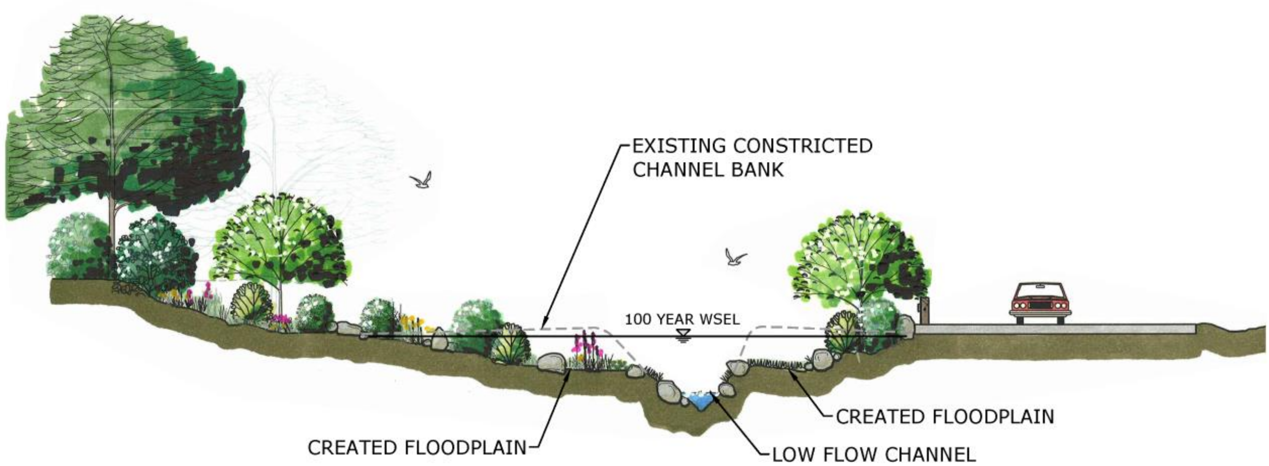
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES STEELE CREEK, HERKIMER COUNTY, NEW YORK

High-Risk Area #3 – Concrete Lined Sections of Channel

Site Description: From just downstream of the Otsego Street bridge (STA 51+00) to just downstream of the West Main Street bridge (STA 14+00), the channel is concrete lined at various sections creating confined as well as high velocity flows. A number of undersized bridges and an undersized channel cause flooding in this reach. The surrounding area is highly commercialized with residential dwellings along both sides of the creek, threatened by overtopping of the concrete channel.

Recommendations:

- Replace undersized bridge crossings that act as hydraulic constrictions and replace with larger spans (if appropriate).
- Remove concrete lining and create naturalized, appropriately sized channel to minimum bankfull dimensions and create floodplain bench.



TYPICAL COMPOUND CHANNEL

	BENEFITS
✓	Improved safety
✓	Reduction in debris jams
✓	Improved hydraulic capacity
✓	Reduced flood hazard
✓	Improved ecological connectivity

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APPENDIX A

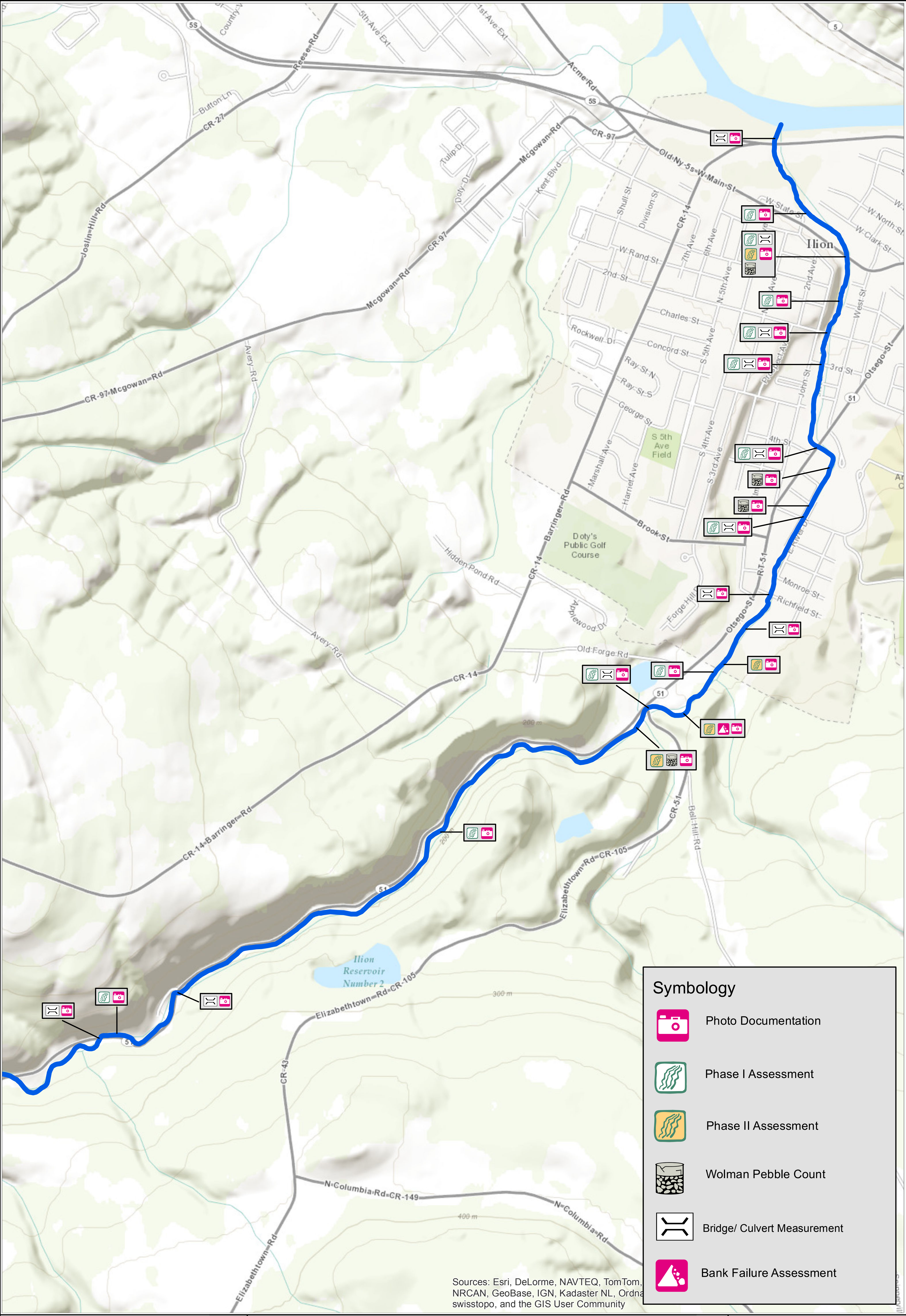
Summary of Data and Reports Collected

ATTACHMENT A: DATA INVENTORY

Year	Data Type	Document Title	Author
2013	Presentation	Flood Control Study for Fulmer Creek	Schnabel Engineering
2012	Map	Sauquoit Creek Watershed/Floodplain Map	Herkimer-Oneida Counties Comprehensive Planning Program
2011	Report	Oriskany Creek Conceptual Plan and Feasibility Study for Watershed Project	Oneida County SWCD
2009	Presentation	Ice Jam History and Mitigation Efforts	National Weather Service, Albay NY
2007	Report	Cultural Resources Investigations of Fulmer, Moyer, and Steele Flood Control Projects	United States Army Corps of Engineers (USACE)
2006	Report	Riverine High Water Mark Collection, Unnamed Storm	Federal Emergency Management Agency (FEMA)
2005	Report	Fulmer Creek Flood Damage Control Feasibility Study	United States Army Corps of Engineers (USACE)
2005	Report	Steele Creek Flood Damage Control Feasibility Study	United States Army Corps of Engineers (USACE)
2004	Report	Fulmer Creek Basin Flood Hazard Mitigation Plan	Herkimer-Oneida Counties Comprehensive Planning Program
2004	Report	Moyer Creek Basin Flood Hazard Mitigation Plan	Herkimer-Oneida Counties Comprehensive Planning Program
2004	Report	Steele Creek Basin Flood Hazard Mitigation Plan	Herkimer-Oneida Counties Comprehensive Planning Program
2003	Report	Fulmer, Moyer, Steele Creek - Stream Bank Erosion Inventory	Herkimer-Oneida Counties Comprehensive Planning Program
1997	Report	Sauquoit Creek Watershed Management Strategy	Herkimer-Oneida Counties Comprehensive Planning Program
2011	Report	Flood Insurance Study (FIS), Herkimer County	Federal Emergency Management Agency (FEMA)
2011	Report	Flood Insurance Study (FIS), Montgomery County	Federal Emergency Management Agency (FEMA)
2013	Report	Flood Insurance Study (FIS), Oneida County	Federal Emergency Management Agency (FEMA)
2010	Report	Bridge Inspection Summaries, Multiple Bridges	National Bridge Inventory (NBI)
2002	Hydraulic Models	Flood Study Data Description and Assembly - Rain CDROM	New York Department of Enviromental Conservation (NYDEC)
2013	Data	June/July 2013 - Post-Flood Stream Assessment	New York State Department of Transportation (NYSDOT)
2013	GIS Data	LiDAR Topography, Street Mapping, Parcel Data, Utility Info, Watersheds	Herkimer-Oneida Counties Comprehensive Planning Program
2013	GIS Data	Aerial Orthographic Imagery, Basemaps	Microsoft Bing, Google Maps, ESRI
2011	GIS Data	FEMA DFIRM Layers	Federal Emergency Management Agency (FEMA)
2013	Data	Watershed Delineation and Regression Calculation	US Geological Survey (USGS) - Streamstats Program

APPENDIX B

Field Data Collection Forms



SOURCE(S):	**Figure 9-1: Steele Creek Data Collection Points**	**Location:** **Herkimer County, New York**

N

NYDOT: Emergency Transportation Infrastructure Recovery

MXD: Y:\5231-01\GIS\Maps\Icon Maps\Steele 9-1.mxd

Map By: CMP
MMI#: 5231-01-02
1st Version: 12/5/2013
Revision: 12/12/2013
Scale: 1 in = 1,333 ft

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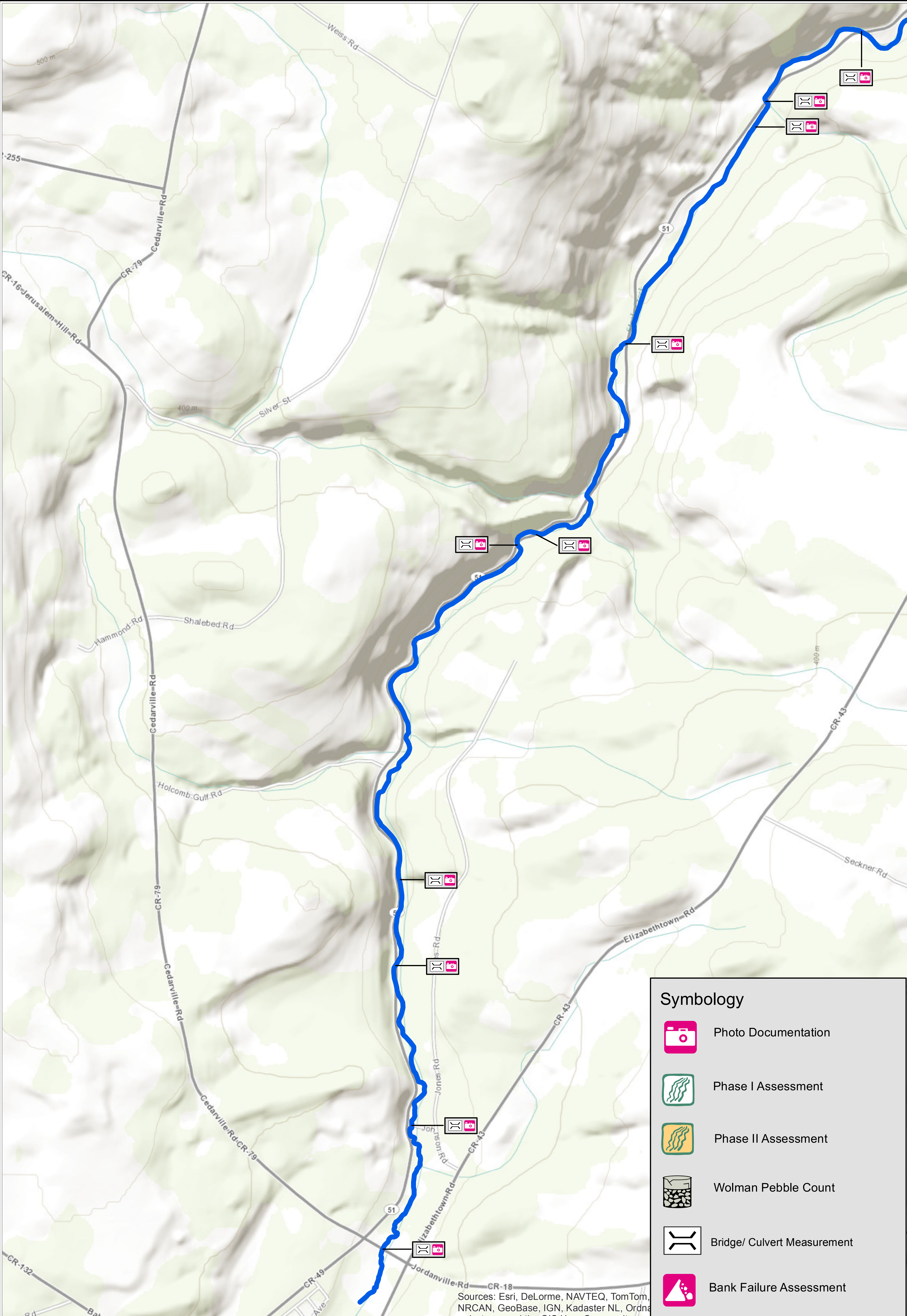

SOURCE(S):

Figure 9-2: Steele Creek Data Collection Points

Location: **Herkimer County, New York**

N

NYDOT: Emergency Transportation Infrastructure Recovery

MXD: Y:\5231-01\GIS\Maps\Icon Maps\Steele 9-2.mxd

Map By: CMP
MMI#: 5231-01-02
1st Version: 12/5/2013
Revision: 12/12/2013
Scale: 1 in = 1,333 ft

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MMI Project #5231-01 Phase I River Assessment Reach Data

River ________________ Reach _____________ U/S Station _______________ D/S Station ___________

Inspectors __________________ Date ______________ Weather ____________________________________

Photo Log ____

A) Channel Dimensions: Bankfull

Width (ft) __________

Depth (ft) __________

Watershed area at D/S end of reach (mi^2) ___________

B) Bed Material:

Bedrock	Boulders	Cobble
Gravel	Sand	Clay
Concrete	Debris	Riprap

Notes: ____

C) Bed Stability: Aggradation Degradation Stable Note: __________________

D) Gradient: Flat Medium Steep Note: __________________

E) Banks: Natural Channelized Note: ________________

F) Channel Type: Incised Colluvial Alluvial Bedrock Note: __________

G) Structures: Dam Levee Retaining Wall Note: _______________

H) Sediment Sources: ____

I) Storm Damage Observations: ____

____

J) Vulnerabilities: Riverbank Development Floodplain Development Road Trail Railroad

Utility Bridge Culvert Retaining Wall Ball field Notes: ________________

K) Bridges: Structure # _____________ Inspection Report? Y N Date ________________

Notes: ____

Record span measurements if not in inspection report: ____

Damage, scour, debris: ____

L) Culverts: complete culvert inspection where necessary. Size: ____

Type: ________________ Notes: ____

____

Phase II River Assessment
Reach Data

River ____________________ Reach ____________ Road _____________ Station ______________

Inspector _________________ Date _____________ Town ____________ County _____________

Identification Number _____________________ GPS # ________________ Photo # ________________

A) River Reach ID _________________________ Drainage Area, sm ________________________
D/S Boundary ______________________________, U/S Boundary ___________________________
D/S STA __________________________________, U/S STA ________________________________
D/S Coordinates ___________________________, U/S Coordinates _________________________

B) Valley Bottom Data:

Valley Type (Circle one)	Confined >80% L	Semiconfined 20-80%	Unconfined <20%
Valley Relief	<20'	20-100'	>100
Floodplain Width	<2 W_b	2-10 W_b	>10 W_b

	Left Side	Right Side
Natural floodplain	_______%	_______%
Developed floodplain	_______%	_______%
Terrace	_______%	_______%
Floodplain Land Use	____________	____________

C) Pattern: Straight S=1-1.05 | Sinuous S=1.05 – 1.25 | Meanders S=1.25 – 2.0 | Highly Meandering S>2.0 | Braided | Wandering | Irregular

D) Channel Profile Form: (Percent by Class in Reach)

Cascades	__________	Alluvial	__________	Channel Transport
Steep Step/Pool	__________	Semi Alluvial	__________	Sed. Source Area
Fast Rapids	__________	Non Alluvial	__________	Eroding
Tranquil Run	__________	Channelized	__________	Neutral
Pool & Riffle	__________	Incised	__________	Depositional
Slow Run	__________	Headcuts	__________	

E) Channel Dimensions (FT):

	Bankfull	Actual Top of Bank	Regional HGR
Width	__________	__________	__________
Depth	__________	__________	__________
Inner Channel Base Width	__________		
W/D Ratio	__________		

F) Hydraulic Regime:
Mean Bed Profile Slope ________________ Ft/Ft
Observed Mean Velocity ______________________ FPS

G) Bed Controls:

Bedrock	Weathered Bedrock	Dam
Static Armor	Cohesive Substrate	Bridge
Boulders	Dynamic Armor	Culvert
Debris	Riprap	Utility Pipe/Casing

Overall Stability _______________________

H) Bed Material:

D50 __________

Bedrock	__________	Sand	__________	Riprap	__________
Boulders	__________	Silt and Clay	__________	Concrete	__________
Cobble and Boulder	__________	Glacial Till	__________		
Gravel and Cobble	__________	Organic	__________		
Sand and Gravel	__________				

I) Flood Hazards:

Developed Floodplains	Bank Erosion
Buildings	Aggradation
Utilities	Sediment Sources
Hyd. Structures	Widening

Bridge Waterway Inspection Summary

River ____________________ Reach ____________ Road _____________ Station ______________

Inspector _________________ Date _____________ NBIS Bridge Number ____________________

NBIS Structure Rating _____________________ Year Built __________________________________

Bridge Size & Type _______________________ Skew Angle ________________________________

Waterway Width (ft) ______________________ Waterway Height (ft) _________________________

Abutment Type (circle) Vertical Spill through Wingwalls

Abutment Location (circle) In channel At bank Set back

Bridge Piers _____________________________ Pier Shape __________________________________

Abutment Material ________________________ Pier Material _________________________________

Spans % Bankfull Width ____________________ Allowance Head (ft) __________________________

Approach Floodplain Width _________________ Approach Channel Bankfull Width _______________

Tailwater Flood Depth or Elevation ___________ Flood Headloss, ft ____________________________

	Left Abutment	Piers	Right Abutment
Bed Materials, D_{50}			
Footing Exposure			
Pile Exposure			
Local Scour Depth			
Skew Angle			
Bank Erosion			
Countermeasures			
Condition			
High Water Marks			
Debris			

Bed Slope	Low	Medium	Steep
Vertical Channel Stability	Stable	Aggrading	Degrading
Observed Flow Condition	Ponded	Flow Rapid	Turbulent

Lateral Channel Stability ____

Fish Passage ____

Upstream Headwater Control ____

Project Information

Project Name	
Project Number	
Stream / Station	
Town, State	
Sample Date	
Sampled By	
Sample Method	Wolman Pebble Count

Particle Distribution (%)

silt/clay	
sand	
gravel	
cobble	
boulder	
bedrock	

Sample Site Descriptions by Observations

Channel type	
Misc. Notes	

Particle Sizes (mm)

D16	
D35	
D50	
D84	
D95	

(Bunte and Abt, 2001)

Particle Name	Size Limits (mm) lower	upper	Tally	Count	Percent Passing	Cumulative % Finer
silt/clay	0	**0.063**			0.0	0.0
very fine sand	0.063	**0.125**			0.0	0.0
fine sand	0.125	**0.250**			0.0	0.0
medium sand	0.250	**0.500**			0.0	0.0
coarse sand	0.500	**1**			0.0	0.0
very coarse sand	1	**2**			0.0	0.0
very fine gravel	2	**4**			0.0	0.0
fine gravel	4	**5.7**			0.0	0.0
fine gravel	5.7	**8**			0.0	0.0
medium gravel	8	**11.3**			0.0	0.0
medium gravel	11.3	**16**			0.0	0.0
coarse gravel	16	**22.6**			0.0	0.0
coarse gravel	22.6	**32**			0.0	0.0
very coarse gravel	32	**45**			0.0	0.0
very coarse gravel	45	**60**			0.0	0.0
small cobble	60	**90**			0.0	0.0
medium cobble	90	**128**			0.0	0.0
large cobble	128	**180**			0.0	0.0
very large cobble	180	**256**			0.0	0.0
small boulder	256	**362**			0.0	0.0
small boulder	362	**512**			0.0	0.0
medium boulder	512	**1024**			0.0	0.0
large boulder	1024	**2048**			0.0	0.0
very large boulder	2048	**4096**			0.0	0.0
bedrock	4096	**-**			0.0	0.0
			Total	0	0.0	-

(Wenthworth, 1922)

F-T Particle Sizes (mm)

F-T n-value	0.5
D16	
D5	

(Fuller and Thompson, 1907)

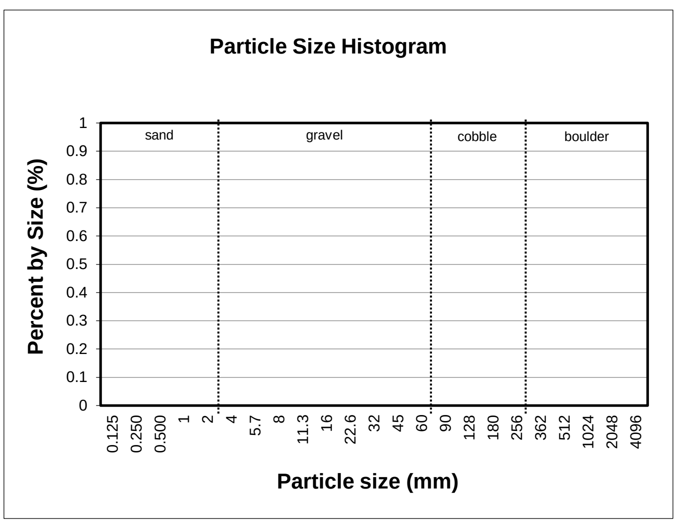
D (mm) of the largest mobile particles on bar

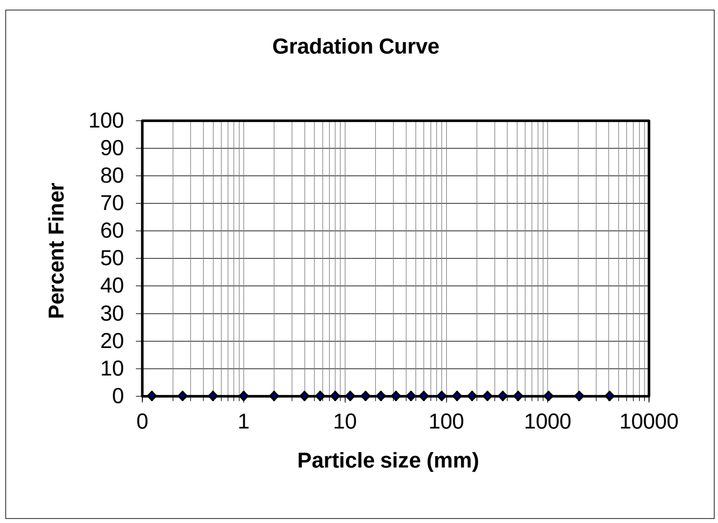
Mean	

Riffle Stability Index (%)

(Kappesser, 2002)

Notes





APPENDIX C

Steele Creek Photo Log

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(203 271-1773

Steele Creek High Risk Areas

MMI# 5231-01
NYDOT
January 2014

PROJECT PHOTOS

PHOTO NO.: **1** DESCRIPTION: Photo taken from Spinnerville Gulf Road crossing, station 110+00, upstream depicting the most severe sediment deposition zone.	
PHOTO NO.: **2** DESCRIPTION: Looking downstream from the Spinnerville Gulf Road crossing is a stone reventment wall preventing erosion of residential properties.	

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(203 271-1773

PHOTO NO.:

3

DESCRIPTION:

Another section of stone wall put in place after the 2013 flooding events in order to prevent further undercutting of this bank. This cut bank is located between stations 104+00 and 108+00.

PHOTO NO.:

4

DESCRIPTION:

Small tributary enters into Steele Creek at station 98+00 and is causing bank erosion on the far side of the river, threatening the gas line.

PHOTO NO.:

5

DESCRIPTION:

Photo taken from newly built Frederick Street bridge looking upstream to where the Philip Street bridge existed before being washed out in the 2013 floods. This straight stretch of river extends over a third of a mile from station 80+00 downstream to station 60+00.

PHOTO NO.:

6

DESCRIPTION:

Dam located along E River Drive at station 64+75 with sporatic concrete channel banks, just downstream of Frederick Street bridge crossing.

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Steele Creek High Risk Areas

MMI# 5231-01
NYDOT
January 2014

PHOTO NO.:

7

DESCRIPTION:

Looking upstream from the Third Street crossing at station 42+50, the channel banks are lined with discontinuous concrete walls. This is one of the many areas that becomes ponded under high flows due to the hydraulic constriction from the bridge.

PHOTO NO.:

8

DESCRIPTION:

A concrete lined section of Steele Creek beginning just upstream of the Main Street bridge at station 27+00 to downstream station 22+00.

APPENDIX D

Detention Basin Computations

USGS New York StreamStats

Streamstats Ungaged Site Report

Date: Mon Jan 27 2014 13:25:00 Mountain Standard Time
Site Location: New_York
NAD27 Latitude: 43.0013 (43 00 05)
NAD27 Longitude: -75.0457 (-75 02 45)
NAD83 Latitude: 43.0013 (43 00 05)
NAD83 Longitude: -75.0453 (-75 02 43)
ReachCode: 02020004000517
Measure: 90.86
Drainage Area: 26.3 mi2
Percent Urban: 0.56 %

Peak Flows Region Grid Basin Characteristics

100% 2006 Full Region 1 (26.3 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	26.3	0.54	4500
Lag Factor (dimensionless)	0.12	0.004	15.229
Percent Storage (percent)	1.16	0	28.92
Percent Forest (percent)	47	23.83	99.61
Mean Annual Precipitation (inches)	41.7	29.49	56.1

Bank Full Region Grid Basin Characteristics

100% Bankfull Region 5 SIR2009 5144 (26.3 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	26.3	0.7	332

Peak Flows Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK1_25	943	32	2.2		
PK1_5	1130	30	2		
PK2	1380	29	2.1		
PK5	2050	27	3.6		
PK10	2540	27	5.1		
PK25	3200	28	6.9		
PK50	3700	29	8		
PK100	4280	31	8.8		
PK200	4810	33	9.4		
PK500	5640	35	9.8		

Bank Full Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
BFAREA	159	24		84.9	299
BFDPTH	2.78	20		1.53	5.03
BFFLOW	744	36		224	2470
BFWDTH	58.6	27		30.3	113

Computed By: JCS 1/27/14
Checked By:________________
MMI# 5231-01

Existing Conditions
Stage vs. Storage

Existing conditions calculations could not be completed due to lack of existing berm.

Alt. 1 - Berm and Grading
Stage vs. Storage

Distance Below Spillway (ft)	Elevation (ft.)	Area (s.f.)	Incremental Volume (c.f.)	Incremental Volume (c.y.)	Incremental Volume with 1 ft Freeboard (c.y.)
0	475	511,695	505,996	18,741	0
1	474	500,297	494,655	18,321	18,321
2	473	489,013	483,427	17,905	17,905
3	472	477,840	472,309	17,493	17,493
4	471	466,777	461,301	17,085	17,085
5	470	455,824	450,403	16,682	16,682
6	469	444,981	439,614	16,282	16,282
7	468	434,246	418,470	15,499	15,499
8	467	402,693	0	0	0
		Total:	**3,307,703**	**122,508**	**103,767**

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JOB 5231-01
SHEET NO. ____ OF ____
CALCULATED BY JCS DATE 1/27/14
CHECKED BY ____ DATE ____
SCALE ____

Steele Creek
@ Sta. 91+00 to 104+00

Total Watershed Contributing to Potential Storage Area:

A= 26.3 mi^2 (streamstats) = 733,201,920 ft^2

Assume 7 in Rainfall & 30% Runoff over entire Watershed:

$V = 733{,}201{,}920\ ft^2 \times 7in \times \frac{ft}{12in} \times 0.3 = 128{,}310{,}336\ CF$

$128{,}310{,}336\ CF \times \frac{CY}{27\ CF} = 4{,}752{,}235\ CY$

Available Storage at Site - includes 1 ft freeboard

Alt. 1 (Berm & Grading)

Storage	Storage (% of V)
103,767 CY	2.2%

2.2% < 10% therefore not feasible

STEELE CREEK STAGE STORAGE

EMERGENCY TRANSPORTATION INFRASTRUCTURE RECOVERY

HERKIMER COUNTY
NEW YORK

SOURCE:
NYDOT LiDAR
Bing Aerials

DESIGNED	DRAWN	CHECKED
---	JCS	---

SCALE: 1 inch = 50 feet

PROJECT NO.: 5231-01

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DATE: January 27, 2014

SHEET: FIGURE 1