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

MUD CREEK
ONEIDA 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
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
HMGP	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
NYSDOT	New York State Department of Transportation
PDM	Pre-Disaster Mitigation
SFHZ	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
WSEL	Water Surface Elevation
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 an emergency transportation infrastructure recovery water basin assessment of 13 watersheds in Herkimer, Oneida, and Montgomery Counties, including the Mud Creek watershed. Prudent Engineering was also contracted through CME to provide support services, including field survey of stream cross sections.

Mud Creek flows through the town of Whitestown, the town of New Hartford, and the town of Kirkland, in Oneida County, east central New York State. The creek is a tributary to Sauquoit Creek and drains an area of 12 square miles. The drainage basin is approximately 40.6 percent forested (*StreamStats*, 2013), with rural residential uses in the upper basin and commercial land uses situated in the lower part of the basin. The creek has an average slope of 1.44 percent over its entire length of 9.0 miles. Figure 1 depicts the contributing watershed of the creek.

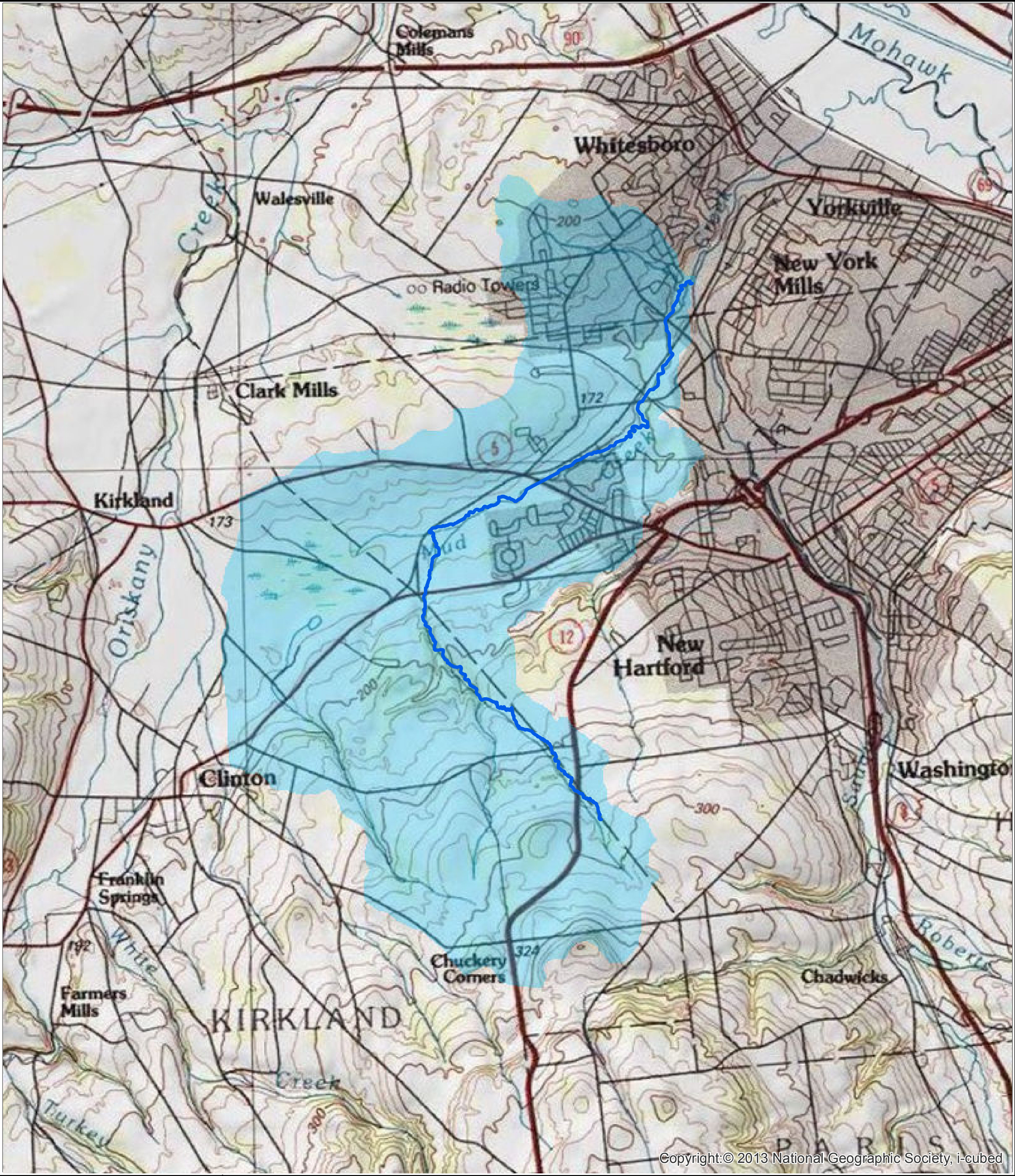
While the upper reaches of Mud Creek have maintained a more rural character, the lower reaches downstream of Clinton Road are densely developed, especially in the areas of Seneca Turnpike, Sangertown Square Mall, and Commercial Drive. Development has occurred within the floodplain and, in some cases, in close proximity to the Mud Creek channel. It is along these lower reaches of Mud Creek where most of the flooding, bank erosion, and flood-related damage have been reported.

The goals of the subject water basin assessment were 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.

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



SOURCE(S):	Figure 1: Mud Creek Drainage Basin Location	LOCATION: Oneida County, New York

NYDOT: Emergency Transportation Infrastructure Recovery

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Map By: CMP
MMI#: 5231-01
Original: 01/06/2014
Revision: 3/20/2014
Scale: 1 inch = 5,000 feet

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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 Mud Creek at STA 0+00 and continues upstream to STA 360+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 Mud 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 Mud 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.

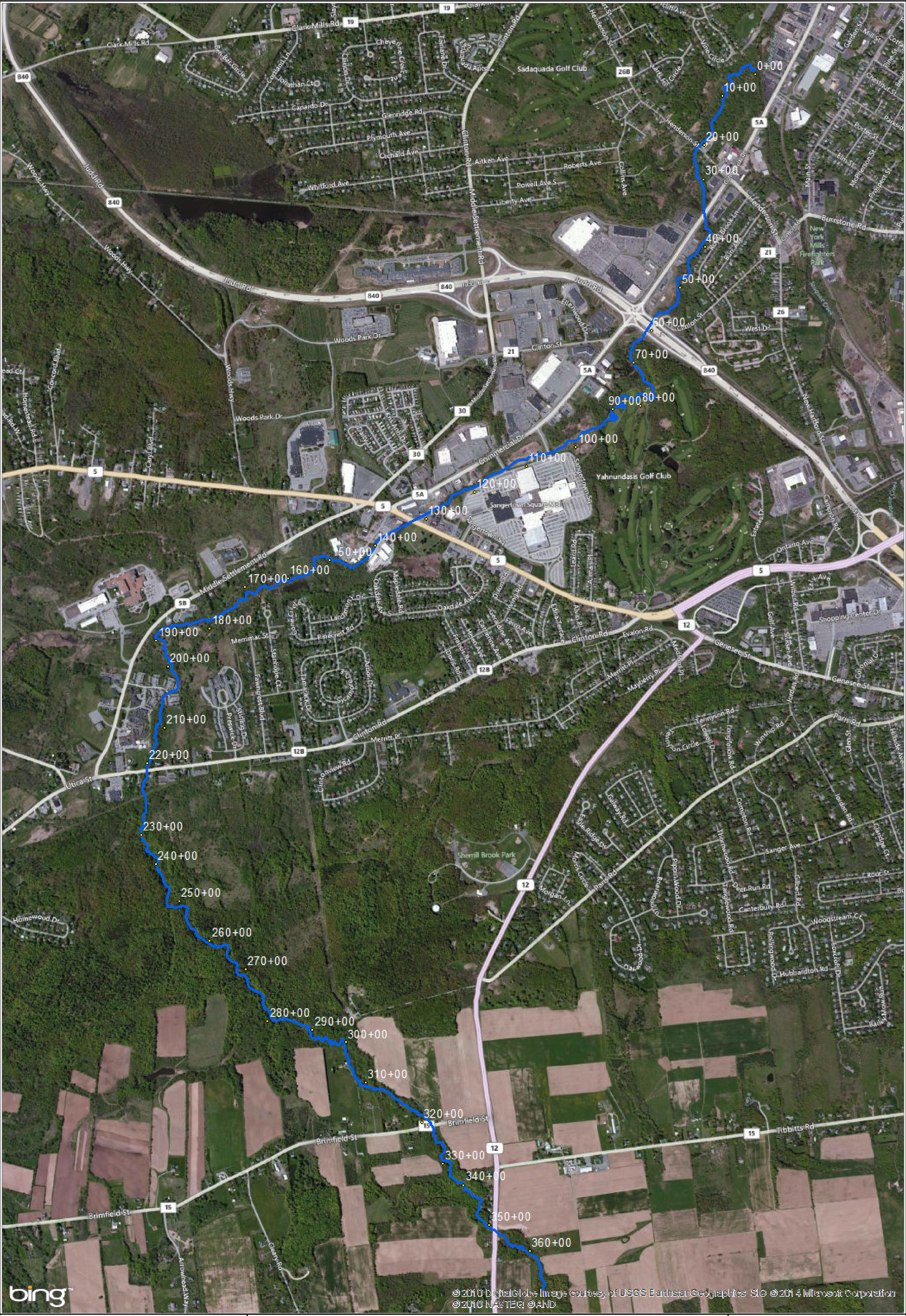
2.2 Public Outreach

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 that was held at the New York Mills Village offices. 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:

- Rapid "windshield" river corridor inspection
- Photo documentation of inspected areas



SOURCE(S):

Figure 2: Mud Creek Watercourse Stationing

Location: **Oneida County, New York**

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NYDOT: Emergency Transportation Infrastructure Recovery

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MMI#: 5231-01
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- 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

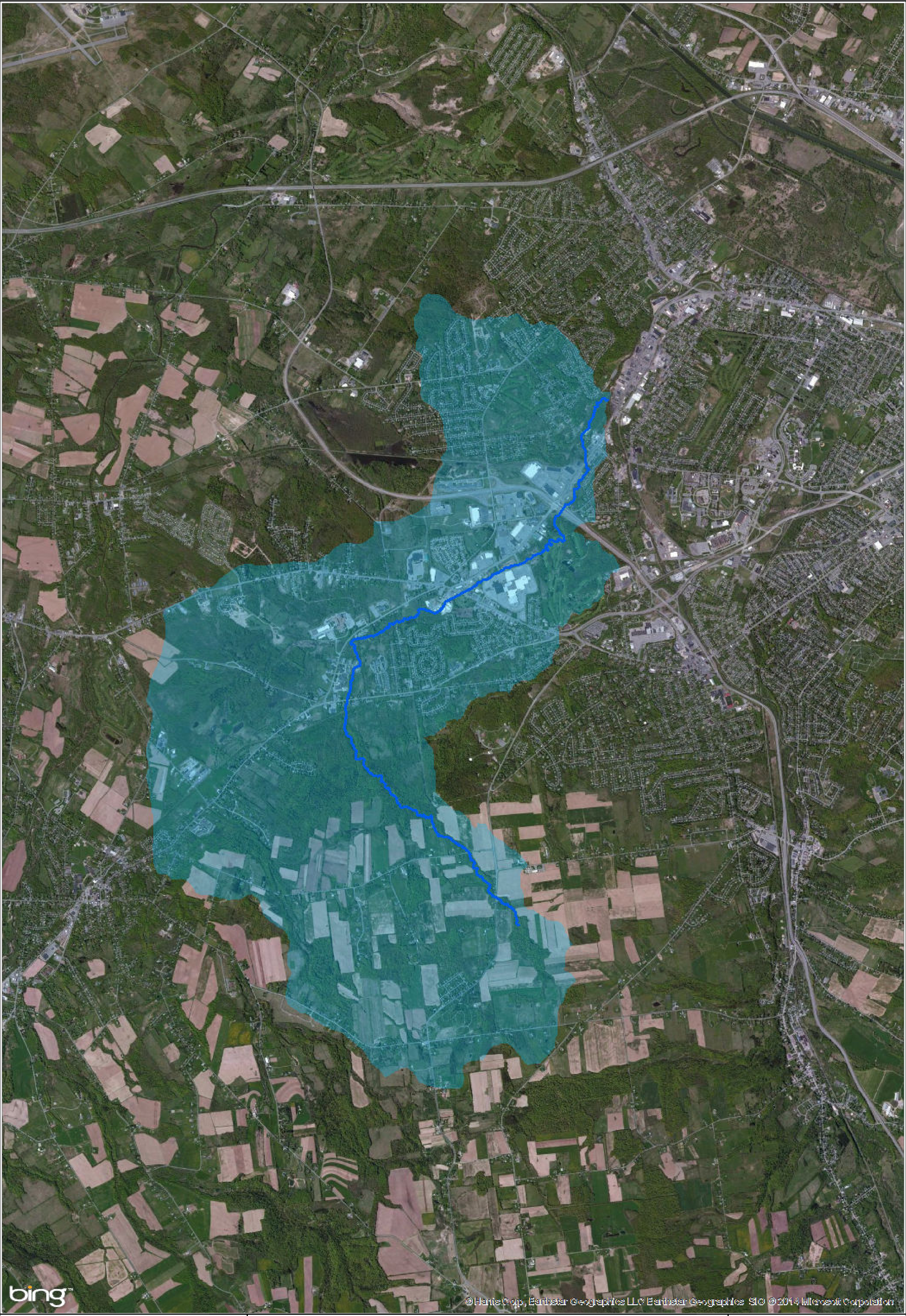
Figure 3 is a watershed map of Mud Creek. The creek flows through the town of Whitestown, the town of New Hartford, and the town of Kirkland in Oneida County. The drainage basin is approximately 40.6 percent forested, with rural residential uses in the upper basin and dense commercial land uses concentrated in the lower part of the basin, especially along Seneca Turnpike and Commercial Drive.

The Mud Creek stream corridor is largely agricultural within the upper reaches, forested through the middle reaches, and heavily commercial in the lower reaches as Mud Creek approaches its outlet at Sauquoit Creek.

2.5 Geomorphology

Mud Creek has an average slope of 1.4 percent over its entire stream length of 9.0 miles. The creek drops a total of 685 vertical feet over its length, from an elevation of 1,123 feet above sea level at its headwaters near Chuckery Corners, to an elevation of 439 feet at its mouth at Sauquoit Creek. Mud Creek is steeper in its upper reaches, above Clinton Road, where the average slope is 2.7 percent. The downstream reaches are flatter, with an average slope of 0.4 percent.

Steep stream reaches such as seen in the upper portions of Mud Creek have more energy than lower gradient reaches and, as a result, have higher velocities that 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.



SOURCE(S):

Figure 3: Mud Creek Drainage Basin Aerial

Location:

Oneida County, New York

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NYDOT: Emergency Transportation Infrastructure Recovery

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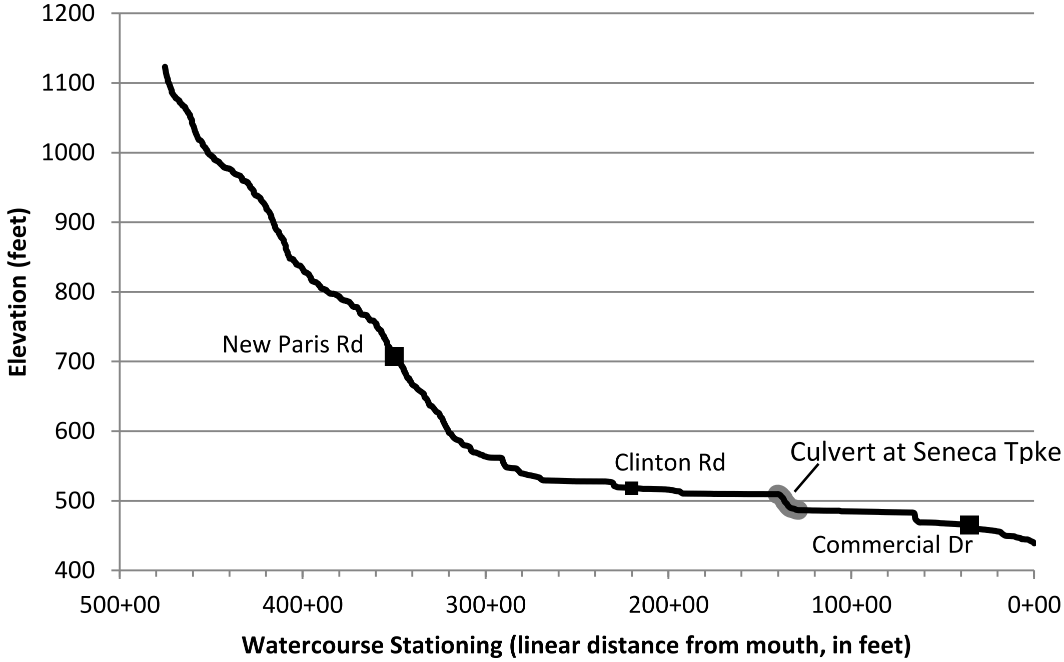
Figure 4 is a profile of Mud Creek showing the watercourse elevation versus the linear distance from the mouth of the watercourse.

Figure 4
Mud Creek Profile



Evidence of bank erosion from the June 2013 flood was seen along the Mud Creek channel in its lower reaches between STA 46+00 and STA 36+00, where the channel parallels Commercial Drive. Stacked rock walls have been constructed along this reach of the channel.

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 that 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 below lists estimated bankfull discharge, width, and depth at several points along Mud Creek, as derived from the United States Geological Survey (USGS) *StreamStats* program.

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

Location Along Mud Creek	Station	Watershed Area (sq. mi.)	Discharge (cfs)	Bankfull Width (ft)	Bankfull Depth (ft)
The Meadows Complex	204+00	3.08	119	22.4	1.25
D/S End of Route 5 Culvert	129+00	8.94	295	36.1	1.86
Henderson Street Crossing	22+50	11.2	358	39.9	2.02

Actual bankfull widths measured on Mud Creek were compared to the regional bankfull channel dimensions reported above. The headwaters of Mud Creek begin in a more naturalistic setting but, progressing downstream, flow through a highly developed area. Based on the regional bankfull widths, the Mud Creek channel is undersized to convey bankfull flows in the more downstream reaches.

There are no USGS stream gauging stations on Mud Creek. Hydrologic data on peak flood flow rates are available from the FEMA FIS and from *StreamStats* regional data. The most current FEMA FIS that applies to Mud Creek is for all of Oneida County. The study was issued on September 27, 2013. According to this FIS, the most recent hydraulic modeling for Mud Creek dates from March 1982.

The hydrologic analysis methods employed in the FEMA study used peak discharge-frequency relationships for Mud Creek obtained from a United States Army Corps of Engineers (USACE) report as determined using the USACE *HEC-1* flood hydrograph computer program (USACE, 1974; USACE, 1981). FEMA applied these discharges in a backwater analysis on Mud Creek, and the resulting water-surface elevations were compared 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 Oneida County.

Estimated peak discharges for various frequency events were calculated using *StreamStats* and compared to peak discharges reported in the FEMA FIS. Table 2 lists estimated peak flows on Mud Creek at each of the cross sections reported in the FEMA FIS and similar drainage points derived from the *StreamStats* program.

Both FEMA and *StreamStats* discharges 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 discharges produced by *StreamStats* are more accurate and better reflect conditions during the June 2013 flooding than discharges estimated by FEMA. Therefore, these were selected for use in the hydraulic analyses. Table 3 reflects the flows that were used in the Hydrologic Engineering Center – *River Analysis System* (HEC-RAS) model.

TABLE 2
Mud Creek FEMA and *StreamStats* Peak Discharges

Location	Drainage Area (sq. mi.)	10-Yr	50-Yr	100-Yr	500-Yr
		FEMA Peak Discharges			
Confluence with Sauquoit Creek	11.5	544	626	677	1,020
Limits of Whitestown/New Hartford	10.9	532	628	648	998
U/S Route 5A	9.77	508	600	620	949
U/S Abandoned Railroad	9.52	759	1,083	1,181	1,998
U/S Seneca Turnpike (Route 5)	7.73	858	1,407	1,518	2,228
U/S Route 5B	3.51	335	476	501	657
		StreamStats Peak Discharges			
Confluence with Sauquoit Creek	12	1,140	1,680	1,950	2,580
Limits of Whitestown/New Hartford	11.3	1,060	1,570	1,810	2,400
NY State Route 5A	11.1	1,040	1,540	1,780	2,360
Abandoned Railroad Bridge	10.1	941	1,390	1,610	2,130
Seneca Turnpike (Route 5)	8.79	800	1,180	1,360	1,800
NY State Route 5B	4.05	334	490	566	747

TABLE 3
Final Hydrology for HEC-RAS Modeling of Mud Creek

Station	Bankfull Flow (cfs)	10-Yr Flow (cfs)	50-Yr Flow (cfs)	100-Yr Flow (cfs)	500-Yr Flow (cfs)
227+00	115	369	556	649	872
149+35	291	800	1,010	1,370	1,810

2.7 Infrastructure

Major crossings over Mud Creek include Route 5 (Seneca Turnpike), Route 840, 5A (Commercial Drive), and Henderson Street. Bridge spans and heights were measured as part of the field inspection. Table 4 summarizes the bridge measurements collected. For the purpose of comparison, estimated bankfull widths at each structure are also included. In addition to numerous bridges, Mud Creek flows through a culvert as it passes beneath Seneca Turnpike, between STA 140+00 and STA 129+00. The culvert is approximately 1,100 feet long.

TABLE 4
Summary of Stream Crossing Data

Location	Station	BIN	Width (ft)	Height (ft)	Bankfull Width (ft)
Clinton Road	220+00	---	19.0	6.6	22.2
The Meadows Apts	205+00	---	19.5	4.2	22.4
Seneca Turnpike Culvert	129+00 - 140+00	---	12.0	8.0	35.8
Sangertown Square #1	115+00	---	12.0 (x2)	8.5	36.6
Sangertown Square #2	106+00	---	---	---	36.6
Route 840	59+00 - 62+50	---	15.0	7.5	39.8
Commercial Drive	35+00	000000001002660	28.0	8.4	39.8
Henderson Street	22+50	000000003310870	25.0	8.2	40.1

Comparing the measurements in Table 4, none of the bridges or culverts is large enough to span the estimated bankfull width of Mud Creek. All of these crossings are within the more densely developed reaches of Mud Creek, downstream of Clinton Road.

The flood profiles provided in the Oneida County FEMA FIS predate the road reconstruction that has occurred involving Route 840, between STA 56+00 and STA 66+00. It appears that an undersized, abandoned railroad crossing and an undersized bridge at Clinton Street have been replaced by a new structure carrying Route 840 over Mud Creek. No recent flooding problems were reported in this area.

Several stream crossings at the Yahnundasis Golf Club, between STA 74+00 and STA 90+00, labeled as "footbridge" on the FEMA profiles, are shown to severely overtop even during the 10-year frequency flood event. However, the bridges are not shown to act as hydraulic constrictions when they overtop. According to the outdated FEMA profile, historic flooding in this area may have been exacerbated by backwater conditions created by the undersized crossings downstream of the golf course, which have now been replaced with a new crossing at Route 840. Flooding of the golf course is not considered to be a high risk situation and was not evaluated further.

The FEMA profiles do not provide adequate information to assess the capacity of the culvert beneath Seneca Turnpike. A hydraulic assessment was conducted by MMI, as discussed in Section 3.6 (High Risk Area #2). FEMA flood insurance rate mapping indicates that the Jay-K lumber yard and commercial buildings located closest to the underground culvert are floodprone in a 100-year event.

3.0 FLOODING CHARACTERISTICS

3.1 Flooding History on Mud Creek

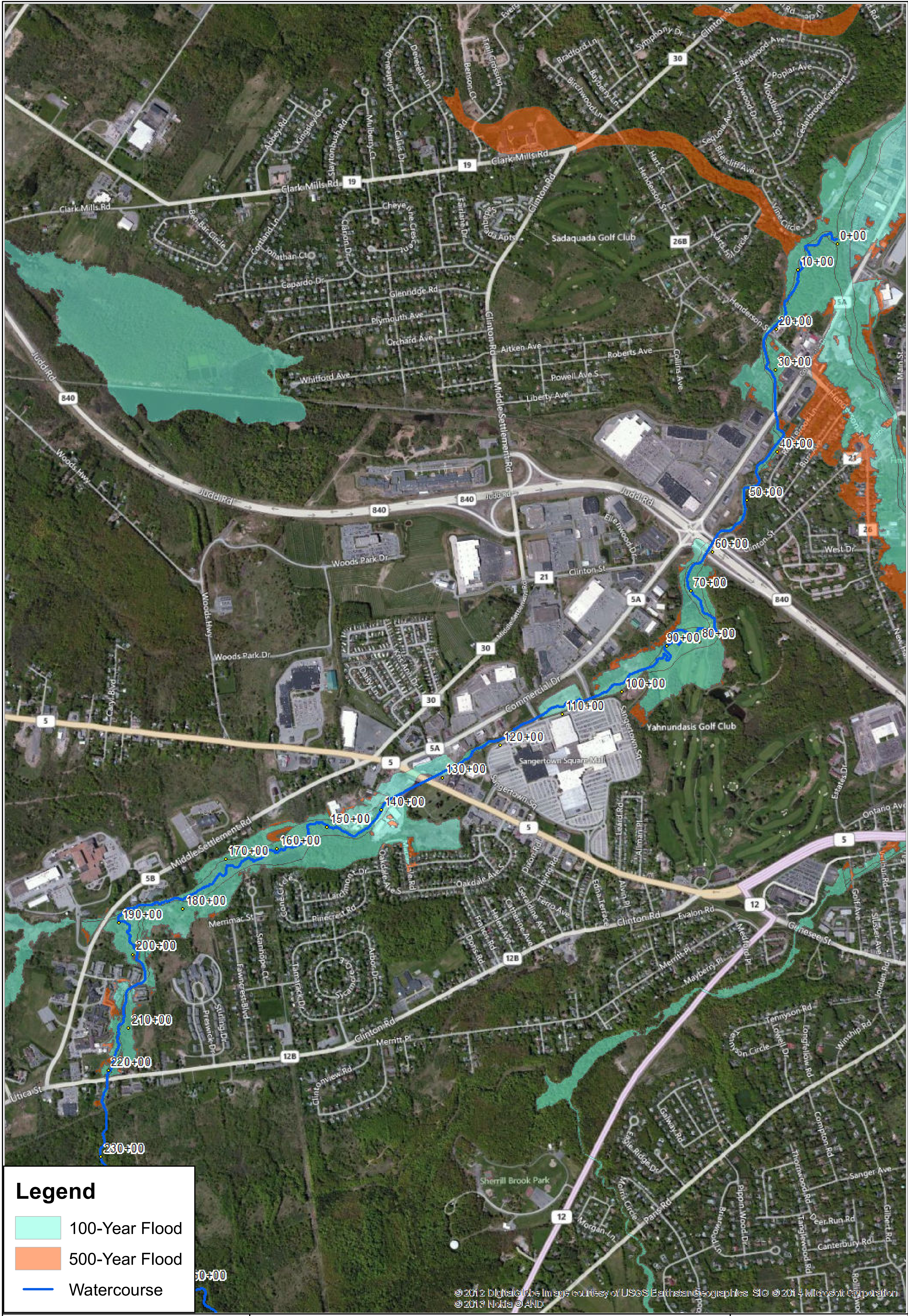
The FEMA FIS for Oneida County reports that flooding can occur during any season of the year. The heaviest precipitation occurs in December, January, June, and July. Most major floods have occurred in March, April, and May and are usually the result of spring rains and snowmelt. Floods in the early summer months are often associated with tropical storms moving north along the Atlantic Coast. Ice jams also contribute to flooding problems. Major flooding and property damage have occurred in the region in 1891, 1922, 1936, 1950, 1959, 1972, 1976, and 1996. Less severe flooding events occurred in January 1999, May 2000, June 2006, and March 2007. The greatest known flood in the Sauquoit Creek basin occurred in March 1936. Intense rains fell on a heavy snow cover, causing Sauquoit Creek to overflow its banks in several areas. In June 1972, Tropical Storm Agnes caused flooding in the Sauquoit Creek basin.

FEMA FIRMs are available for Mud Creek (Figure 5). The maps indicate that flooding occurs in the vicinity of The Meadows at Middle Settlement, upstream of and around the culvert that passes beneath Seneca Turnpike, at the Yahnundasis Golf Club, in the vicinity of Commercial Drive, and at the confluence of Mud Creek and Sauquoit Creek. In the lower reaches of Mud Creek, some of the flooding is associated with flows originating from Sauquoit Creek.

In mid to late June and early July 2013, a severe precipitation system caused excessive flow rates and flooding in a number of communities in the greater Utica region, including in the Mud 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 Mud Creek basin.

Records on the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) Advanced Hydrologic Prediction Service website indicate that 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.

Municipal officials report flooding issues on Mud Creek in the independent living apartment campus called The Meadows at Middle Settlement (STA 209+00 to STA 200+00), in the vicinity of the culvert under Seneca Turnpike (STA 140+00 to STA 129+00), and at the confluence with Sauquoit Creek (STA 4+00 to STA 0+00). Flooding at the confluence with Sauquoit Creek is due to the combined influence of both creeks and is addressed in the Sauquoit Creek report. Bank erosion issues have been reported along Commercial Drive (STA 46+00 to STA 36+00).



SOURCE(S):	Figure 5: Mud Creek FEMA Floodzones	Location: Oneida County, New York
	NYDOT: Emergency Transportation Infrastructure Recovery	Map By: CMP MMI#: 5231-01 MXD: Y:\5231-01\GIS\Maps\FEMA FIRM Maps\Mud FEMA Figure X.mxd 1st Version: 01/06/2014 Revision: 4/11/2014 Scale: 1 in = 1,250 ft

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3.2 Post-Flood Community Response

The Mud Creek channel parallel to Commercial Drive near STA 40+00 experienced erosive damage during the June 2013 flooding, which resulted in damaged banks and a migrating/eroding channel. Post-flood work was performed in an effort to mitigate the damage, including bank stabilization and channel relocation work. At the time of this writing, the repairs were showing signs of further erosion and damage and are likely to require repair in the future.

An apartment complex known as The Meadows at Middle Settlement also experienced flooding during the June event. A portion of Mud Creek flows through the complex, within which four apartment buildings are located on the opposite bank of Mud Creek from the remainder of the complex. These four buildings are accessed by an undersized bridge that is prone to flooding. A secondary flood channel was constructed to direct water around the outside of these four buildings, and flow is currently split between both channels. This causes the four buildings to be isolated on an "island" as flood waters flow on all sides of the buildings.

3.3 Flood Mitigation Analysis

Hydraulic analyses of key reaches along Mud Creek were conducted using the HEC-RAS program. The HEC-RAS computer program (*River Analysis System*) was written by the USACE Hydrologic Engineering Center (HEC) and is 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 1981 study of Mud 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 18 stream cross sections, plus the survey of two bridges/culverts. 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 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 Multi-Locational High Risk Areas: Floodplain Development

The communities of Whitesboro, New York Mills, and New Hartford are heavily developed, with areas of dense residential, commercial, and some industrial land uses. Some of the most densely developed areas are located along the main highways, such as New York Route 5A (Commercial Drive) and Route 5B (Middle Settlement Road), which also generally follow the Mud Creek channel. Along this corridor are multiple areas of development that appear to encroach on the floodplain of Mud and Sauquoit Creeks. These areas have reported heavy flooding during severe precipitation events and in some cases have been subject to repetitive losses after damaged structures were rebuilt in place.

General recommendations for high risk floodplain development follow three basic strategies: (1) removing the floodprone facilities from the floodplain; (2) adapting the facilities to be flood resilient under repetitive inundation scenarios; or (3) relocating the watercourse around the development, if possible.

In order to effectively mitigate flooding along substantial lengths of a watercourse corridor, floodplain management should restrict the encroachment on natural floodplain areas. Floodplains act to convey floodwaters downstream, mitigate damaging velocities, and provide areas for sediment to accumulate safely. The reduction in floodplain width of one reach of stream often leads to the increase in flooding upstream or downstream; a finite amount of water with an unchanging volume must be conveyed during a flood event and, as certain conveyance areas are encroached upon, floodwaters will often expand into other sensitive areas.

A critical evaluation of existing floodplain law and policies should be undertaken to evaluate the effectiveness of current practices and requirements. Local floodplain regulations should be consistent with the National Flood Insurance Program (NFIP) and FEMA regulations and should involve a floodplain coordinator and a site plan review for all proposed developments. This review should determine if the proposed development could impact the floodplain or floodway and would not allow any fill in the floodplain or floodway of any watercourse.

3.5 High-Risk Area #1 – The Meadows at Middle Settlement (STA200+00 to STA 209+00)

Figure 6 is a location plan of High Risk Area #1. This area is located in the vicinity of an independent living apartment campus called The Meadows at Middle Settlement (STA 209+00 to STA 200+00). Portions of the complex were constructed in the floodplain of Mud Creek. Reports from community officials and residents confirm that the apartments are often flooded during severe rain events.

The primary channel of Mud Creek flows through the complex. Four apartment buildings were constructed on the eastern side of Mud Creek, with a bridge spanning the creek to provide access to them. The remaining 20 buildings were constructed on the western side of the creek, six of which are subject to flooding based on FEMA mapping. The four buildings located on the eastern side are especially floodprone as they are situated directly in the center of the floodplain and at a low elevation.

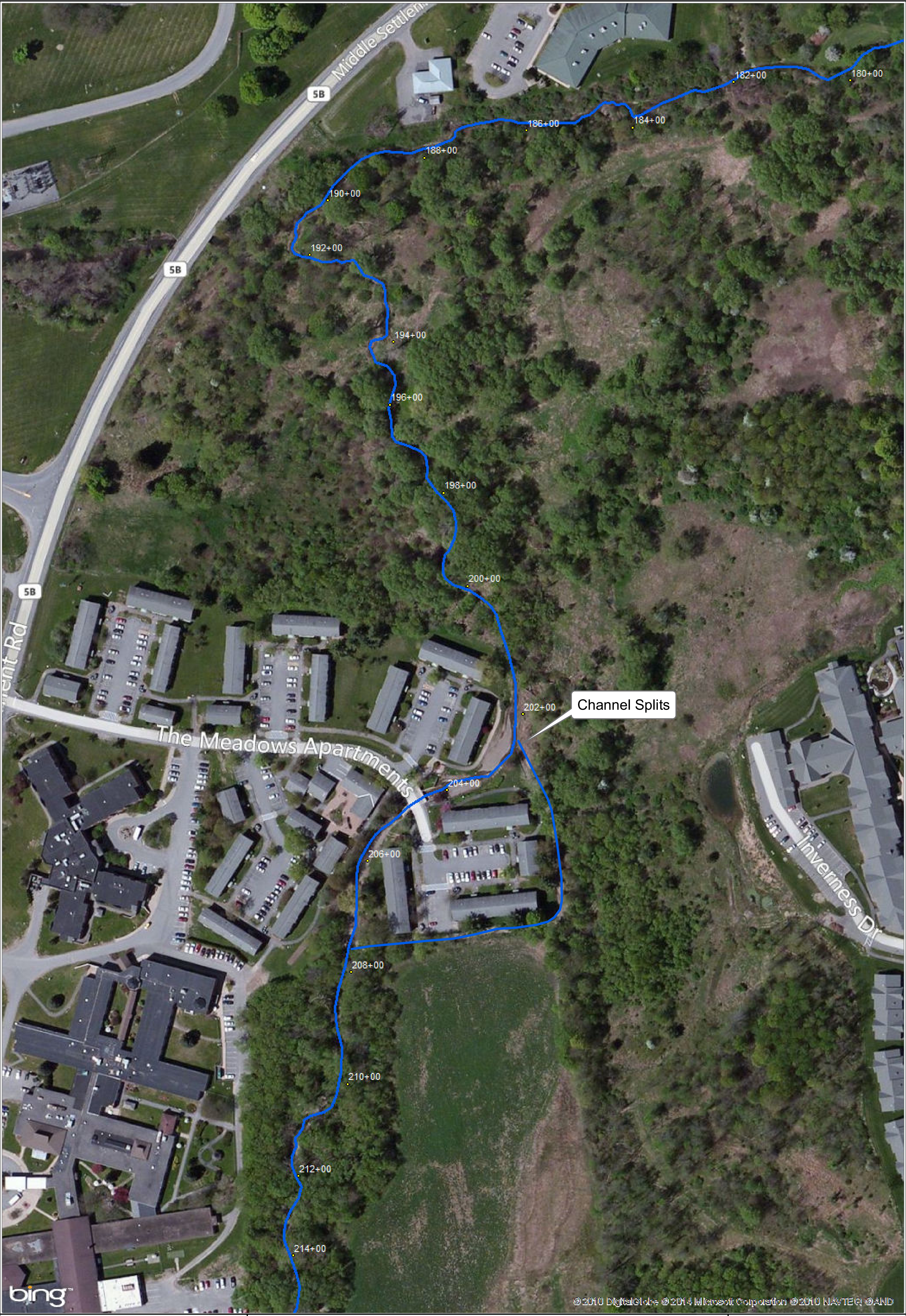
A flow diversion has been created at the upstream end of the four eastern apartment buildings near STA 207+90 for the purpose of diverting water around the south and east of the four eastern buildings. However, this causes floodwaters to flow around all sides of the buildings, creating an island during flooding conditions. Reports from community representatives indicate that this diversion was not successful in mitigating flooding during the June 2013 event and created an unsafe situation where floodwaters were directed on all sides of the residential structures, stranding residents.

Based on hydraulic modeling, Mud Creek would need a bankfull channel of at least 22 to 25 feet wide by 1.5 to 2.0 feet deep to adequately convey bankfull flows without overtopping the banks or causing channel instability. It does not currently meet these criteria.

The floodprone apartment buildings at the Meadows complex are not elevated above the floodplain and sit approximately three feet higher than the channel. In order to prevent flooding of the buildings, Mud Creek would require a floodplain width of at least 130 feet to allow water to disperse and to maintain water surface elevations below the apartment buildings. Three mitigation alternatives have been identified for this area. These involve relocating or removing floodprone buildings, floodproofing the buildings, or relocating the creek.

Alternative 1-1: Acquire and Remove Apartment Buildings From Floodplain

New construction within a floodplain is typically regulated at the local level to maintain compliance with requirements of the NFIP. Buildings constructed prior to the 1968 implementation of the program were exempt from such regulation, resulting in development that is prone to flood damage. The apartment buildings along Mud Creek associated with The Meadows at Middle Settlement complex were likely constructed in such an era, were not elevated, and were not constructed using modern flood resilience standards.



SOURCE(S):

Figure 6: Mud Creek High Risk Area #1

Location:
Oneida County, New York

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Map By: CMP
MMI#: 5231-01
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In areas along Mud Creek where dwellings have suffered repeated losses due to flooding, property acquisition should be considered either through a FEMA buyout program or governmental buy-out. Such properties can be converted to passive, non-intensive land uses such as streamside parks, picnic areas, fishing access sites, or wildlife observation areas.

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 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.

Alternative 1-2: Floodproofing and Flood Protection of Individual Properties

In order to maintain the buildings in their current location, the owner of the apartments could consider taking steps to increase the resiliency of the buildings to flooding. Potential measures for property protection include the following:

Elevation of the structures. 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. Given the size of the apartment buildings, elevation may not be structurally feasible.

Construction of property improvements such as barriers, floodwalls, and earthen berms. Such structural projects can be used to prevent shallow flooding. This may be an option for the buildings on the western side of Mud Creek but would create an isolated island on the eastern side and is not recommended.

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 utilities and belongings. Some may not be feasible at the Meadow's complex by virtue of the internal layout of the apartments.

- 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.

Alternative 1-3: Relocate Creek Away From Apartments

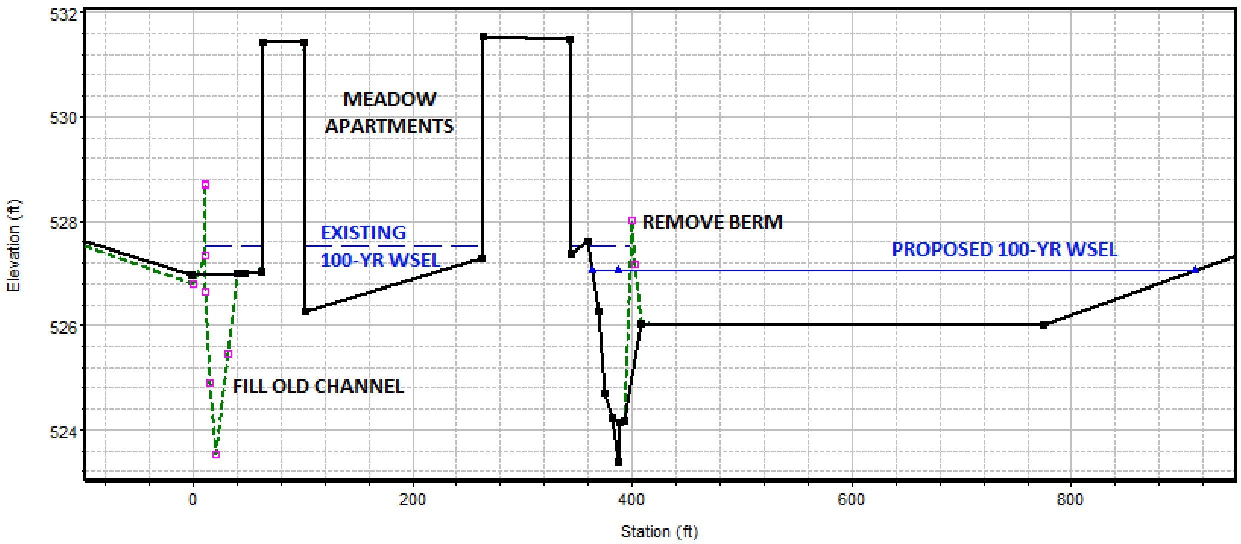
A third alternative to mitigating flooding at the Meadows apartment complex involves the relocation of the primary Mud Creek channel to an area where it is allowed to flood without impacting surrounding buildings. A secondary flood channel to the east of the four floodprone buildings located to the east of Mud Creek was constructed at some point in an effort to provide more flood conveyance. This secondary channel is bordered by agricultural fields that are likely prone to flooding under current conditions.

The widening and appropriate armoring of a relocated channel would allow it to become the primary flow path for the creek. The current creek bed and secondary flood channel would then be filled and the bridge removed. A vegetated buffer and berm located along the flood channel as it adjoins the agricultural fields appears to be influencing flood water elevations as well and should be removed.

Relocation of the channel alone would not mitigate flooding of the apartment buildings. Raising the grade along the apartment side of the new creek and lowering the banks along the agricultural field side would encourage flood flows to spread into the fields during a flood instead of into the apartments. This may involve lowering grade in some portions of the fields and armoring certain areas that may be prone to erosion during flood events, which would require an easement over the land.

Figure 7 presents a cross section through the apartments, showing flooding during a 100-year event under current conditions, as well as the anticipated reduction in flooding after relocation of Mud Creek. Filling of the old channel would discourage floodwaters from entering the complex, and relocating the channel around the apartments would allow it to access a floodplain. A more detailed analysis and site grading plan would have to be developed to ensure the proper design of the flood mitigation measures.

FIGURE 7
Hydraulic Modeling Output – Cross Section Through Meadows Apartments

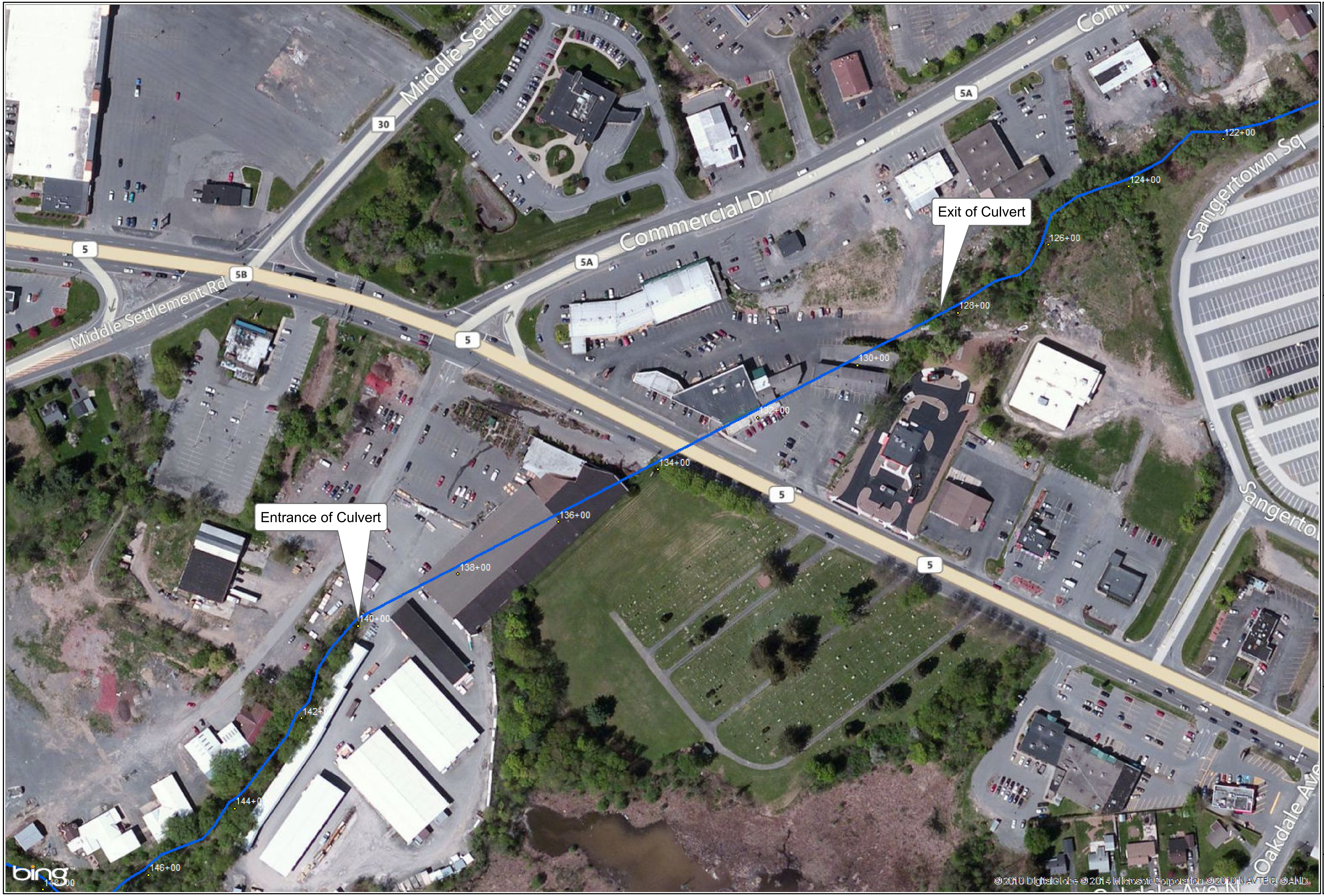


Recommendation

Alternative 1-3 would provide the most permanent, long-term solution and would have less impact to residents. However, the feasibility of this alternative will depend upon the ability to gain an easement over the agricultural land and the cost of the project. The cost of stream relocation should be compared against the cost of acquisition of the buildings (Alternative 1-1). An acquisition would also depend upon the willingness of the owner to sell.

3.6 High-Risk Area #2 – Culvert Under Seneca Turnpike (STA 128+70 to STA 140+10)

Figure 8 is a location plan of High Risk Area #2 in the area of a ±1,140-foot-long culvert under Seneca Turnpike. The upstream end of the culvert is located at STA 140+10 and was measured as an eight-foot-high by 12.5-foot-wide corrugated metal arch. The interior of the culvert was not measured, and its alignment is not known. The downstream end of the culvert located at STA 128+70 is 13 feet wide by seven feet high. Hydraulic modeling of the existing culvert indicates that it is undersized to carry severe flood flows, which is consistent with the FEMA flood insurance rate mapping that indicates the lumber yard and commercial buildings located closest to the underground culvert are floodprone in a 100-year event.



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SOURCE(S):

Figure 8: Mud Creek High Risk Area #2

NYDOT: Emergency Tranportation Infrastructure Recovery

Oneida County, New York

Map By: CMP
MMI#: 5231-01
MXD: Y:\5231-01\GIS\Maps\High Risk Areas\Mud High Risk #2.mxd
1st Version: 1/22/2014
Revision: 3/20/2014
Scale: 1 in = 150 ft

Figure 8

Hydraulic modeling predicts that the culvert under Seneca Turnpike will be overtopped during flows larger than the 10-year recurrence. In order to reduce flooding at this location, three alternatives were identified.

Alternative 2-1: Replace the Existing Culvert With a Larger Culvert

Replacing the existing culvert with a larger structure would convey flood flows without inundating the surrounding area. Hydraulic modeling indicates that a box culvert 30 feet wide by seven feet tall would have sufficient capacity to convey a 100-year flow event but would overtop during a 500-year event. Considering the length of this culvert, necessary water control, and traffic control requirements, the cost is likely to be high.

Alternative 2-2: Add an Additional Parallel Culvert

Adding a supplemental culvert to increase flood flow conveyance would reduce the frequency and severity of flooding. A box culvert with approximate dimensions of 16 feet wide by eight feet high in addition to the existing culvert in aggregate would have sufficient capacity to convey a 100-year flow event but would overtop during a 500-year event. As with Alternative 2-1, the cost of materials to install this large culvert is likely to be high.

Alternative 2-3: Daylight the Existing Culvert

Conveyance could also be increased by replacing the existing culvert with an open channel and a conventional bridge over Mud Creek. Although creation of a more naturalistic floodplain would be preferable, it would need to be on the order of 60 feet in width. The density of surrounding development in this area may not allow such a wide swath of land to be restored as open floodplain. Therefore, a rectangular channel with vertical walls was modeled.

A 30-foot-wide channel would be the minimum width necessary to safely convey flood flows through this area without overtopping the banks during the 100-year flood flow. Any locations where development can be reconfigured to allow the restoration of floodplain would provide incremental benefit and should be pursued.

Recommendation

Daylighting the culvert beneath Seneca Turnpike as described in Alternative 2-3 is recommended. In addition to more effectively conveying flood flows, this alternative may provide opportunity for floodplain restoration in areas where development can be reconfigured. All three alternatives will impact private properties in the floodplain, requiring acquisition of easements for the work. In all cases, addressing the culvert may not effectively mitigate flooding through portions of the Jay-K lumber yard located on the south side of Route 5. Much of this facility appears to have been constructed by filling in the floodplain and is likely subject to frequent inundation.

3.7 High-Risk Area #3 – Commercial Drive (STA 36+00 to STA 46+00)

Figure 9 is a location plan of High Risk Area #3. Mud Creek from approximately STA 46+00 downstream to STA 36+00 is constrained on both banks due to encroachment of homes and businesses onto the floodplain. As a result of this encroachment into the floodplain, the stream banks through this reach are prone to erosion due to high velocities. Recent bank and channel stabilization projects have been implemented in an effort to restore the banks but still show signs of damage from continued erosion and scour. Based on channel measurements collected in the field and comparisons to regional bankfull channel dimensions, the channel of Mud Creek through this reach is undersized.

Alternative 3-1: Restore 1,000 Linear Feet of Channel

This alternative would involve the construction of a larger Mud Creek channel from approximately STA 46+00 downstream to STA 36+00. The larger, more naturalistic channel could be sized to convey flows up to the bankfull flood event and could include a created floodplain to convey larger flood events. The restored channel would be approximately 40 feet in width, with an additional floodplain approximately 80 to 100 feet in total width. This alternative would require the acquisition of property adjacent to Mud Creek, either back yards behind homes along Royal Brook Lane, rear parking areas behind businesses along Commercial Drive, or a combination of both.

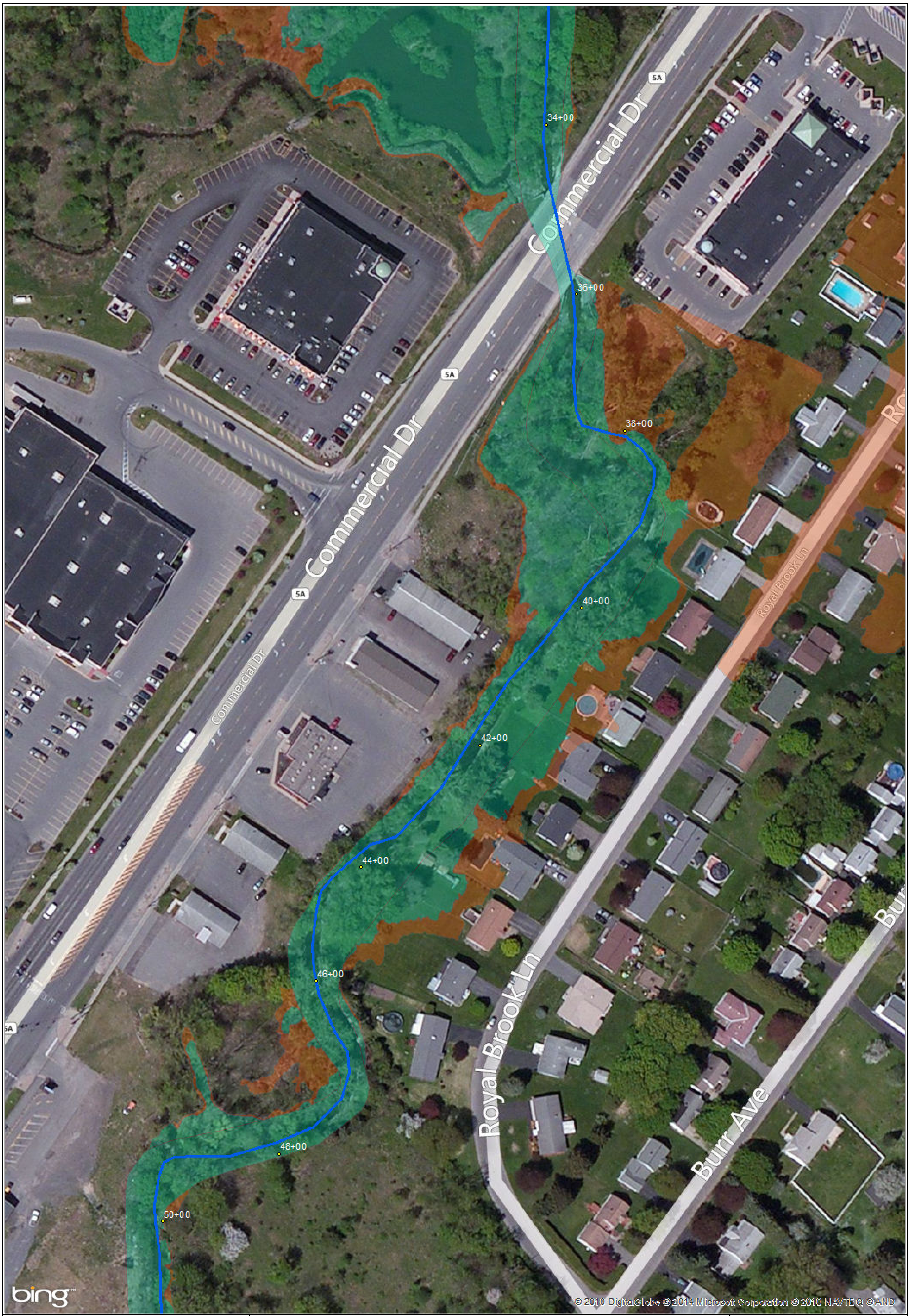
Recommendation

Restoration of the Mud Creek channel between STA 46+00 and STA 36+00, as described in Alternative 3-1, is recommended.

4.0 RECOMMENDATIONS

1. *Stream Relocation or Building Acquisition Near The Meadows at Middle Settlement Apartment Complex (STA 209+00 to STA 200+00)* – If feasible, relocation of Mud Creek in the area of this apartment complex is recommended. Feasibility will depend upon the ability to gain an easement over the agricultural land and the cost of construction. The cost of stream relocation should be compared against the cost of acquisition of the floodprone buildings. The feasibility of acquisition will depend upon the willingness of the owner to sell and the cost. Relocation of Mud Creek would provide the most permanent, long-term solution and would have less impact to residents.

2. *Daylight the Existing Culvert Under Seneca Turnpike (STA 128+70 to STA 140+10)* – Removal of the culvert under Seneca Turnpike and construction of a new wider channel and bridge crossing in the location of the former culvert are recommended. A 30-foot-wide channel would be the minimum width necessary to safely convey flood flows through the area without overtopping the banks.



SOURCE(S):

Figure 9: Mud Creek High Risk Area #3

Location:
Oneida County, New York

N

NYDOT: Emergency Transportation Infrastructure Recovery

Map By: CMP
MMI#: 5231-01
MXD: Y:\5231-01\GIS\Maps\High Risk Areas\Mud High Risk #3.mxd
1st Version: 01/06/2014
Revision: 3/20/2014
Scale: 1 in = 100 ft

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3. *Restoration of Channel Along Commercial Drive* – Property acquisition adjacent to Mud Creek between STA 46+00 and STA 36+00 and construction of a larger, naturalistic channel are recommended. The new channel should be sized to convey flows up to the bankfull flood event and be designed to include a floodplain capable of conveying larger flood events.

4. *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.

5. *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.

6. *Monitor Minor Bank Failures and Erosion* – Several areas of eroding banks, minor bank failures, and slumping hill slopes were observed along Mud 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.

The above recommendations are graphically depicted on the following pages. Table 5 provides an estimated cost range for key recommendations.

TABLE 5
Cost Range of Recommended Actions

	Approximate Cost Range				
Mud Creek Recommendations	< $100k	$100k-$500k	$500k-$1M	$1M-$5M	>$5M
Stream Relocation at Middle Settlement				X	
Daylight the Existing Culvert Under Seneca Turnpike					X
Restoration of Channel Along Commercial Drive				X	

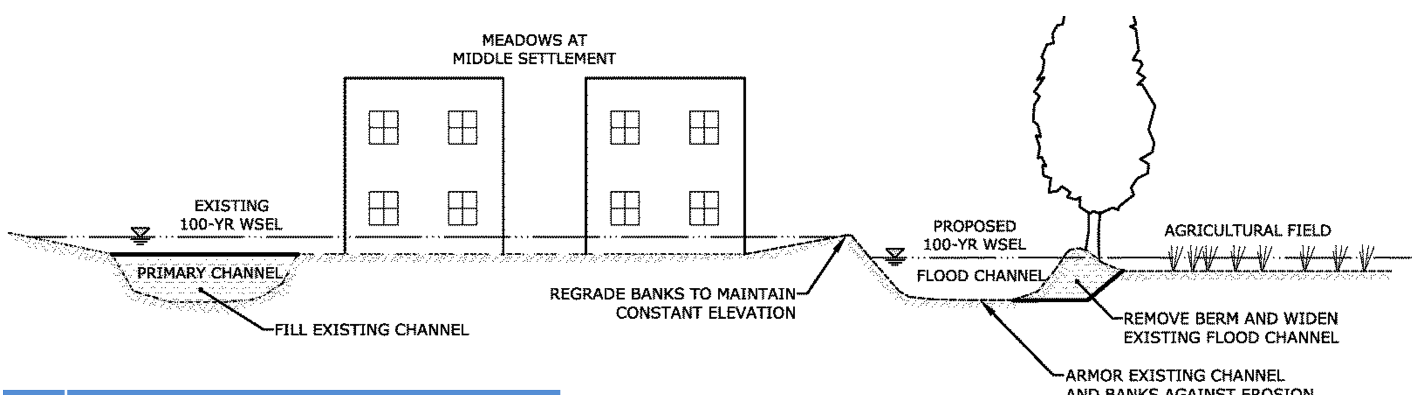
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES
MUD CREEK, HERKIMER COUNTY, NEW YORK

High-Risk Area #1 – The Meadows at Middle Settlement

Site Description: Between STA 209+00 and STA 200+00, parts of the Middle Settlement Complex have been constructed in the floodplain of Mud Creek. A flow diversion has been created to mitigate flooding although is not successful, acting to isolate 4 buildings and strand residents during severe flooding.

Recommendations:

- Relocate the primary channel outside of the floodprone buildings.
- Provide armoring and grade changes to encourage floodwaters to overtop into the adjacent agricultural field and natural floodplain rather than towards the apartments.



	BENEFITS
✓	Improved safety
✓	Improved hydraulic capacity
✓	Reduced flood hazard
✓	Improved ecological connectivity

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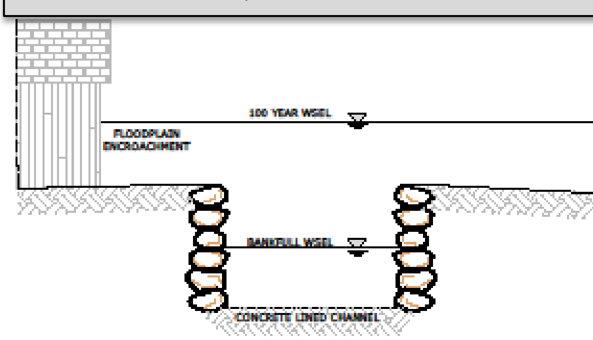
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES
MUD CREEK, HERKIMER COUNTY, NEW YORK

High-Risk Area #2 – Culvert beneath Seneca Turnpike

Site Description: As Mud Creek flows through the heavily developed area near Commercial Drive, the creek flows beneath Route 5- Seneca Turnpike via a large culvert. The culvert is approximately 1,140 feet long overtops during flows greater than a 10-year recurrence.

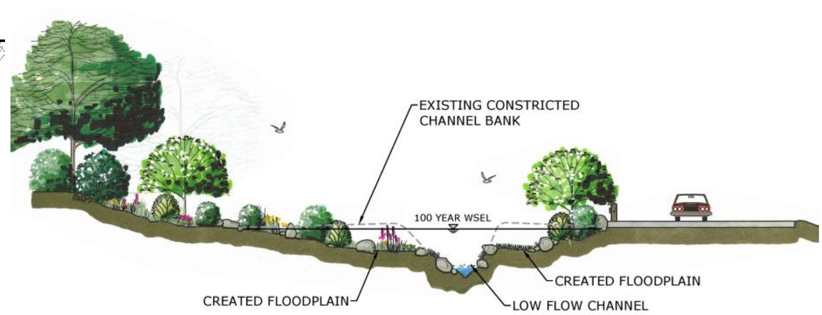
Recommendations:

- Removal of the existing culvert and construction of a new channel in its former location, with a more conventional bridge installed to carry Route 5.
- Either a natural floodplain with a width of 60 feet is recommended or a rectangular channel with concrete walls, 30 feet in width be constructed to adequately convey a minimum of 100-year flow.



TYPICAL CONSTRAINED CROSS SECTION

	BENEFITS
✓	Improved safety
✓	Improved hydraulic capacity
✓	Reduced flood hazard
✓	Improved ecological connectivity



TYPICAL COMPOUND CHANNEL

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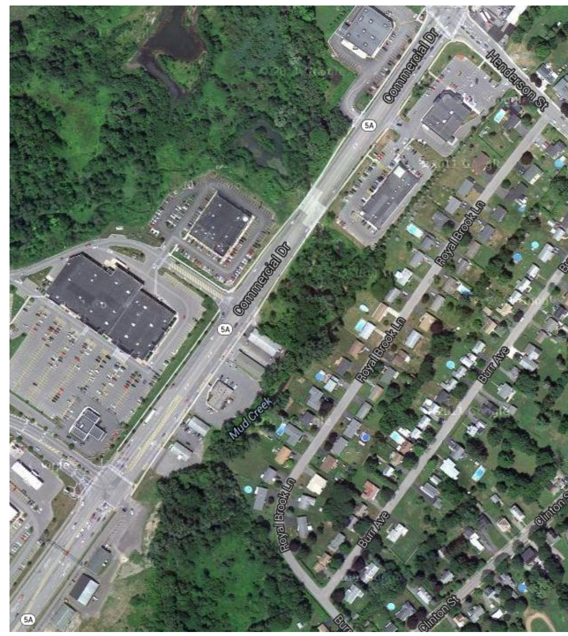
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES
MUD CREEK, HERKIMER COUNTY, NEW YORK

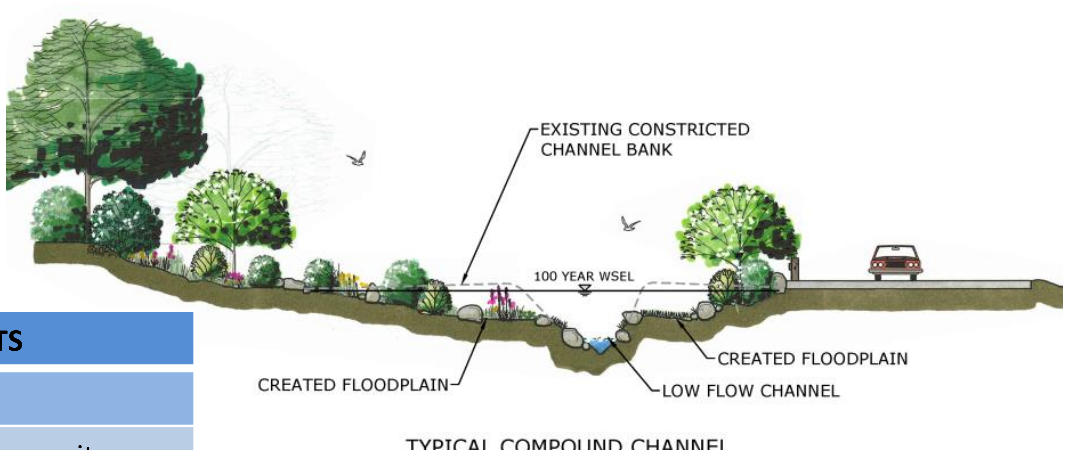
High-Risk Area #3 – Flooding on Commercial Drive

Site Description: Mud Creek flows alongside Commercial Drive where fill was historically placed in the floodplain to allow for increased development, but this additional encroachment has increased velocities causing bank and channel instability through this reach. A number of stabilization measures have been put in place, with limited success.



Recommendations

- Floodplain development should be minimized and eliminated, where possible. Restoration of the natural floodplain should be sought through regulatory restriction of floodplain development, and the long-term procurement of floodprone properties.



	BENEFITS
✓	Improved safety
✓	Improved hydraulic capacity
✓	Reduced flood hazard
✓	Improved ecological connectivity

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APPENDIX A

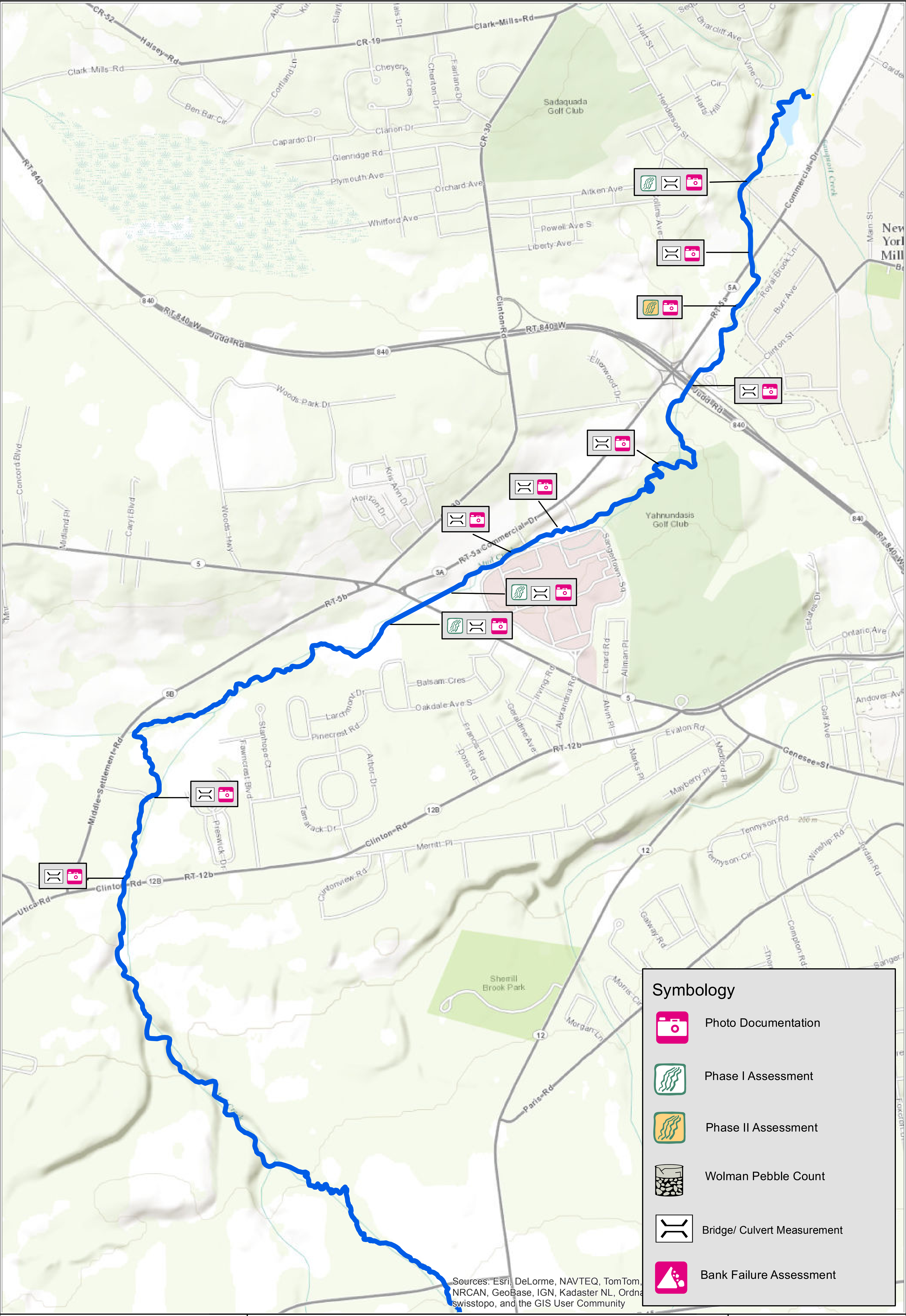
Summary of Data and Reports Collected

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):

Appendix B: Mud Creek Data Collection Points

Location: **Oneida County, New York**

NYDOT: Emergency Transportation Infrastructure Recovery

MXD: Y:\5231-01\GIS\Maps\Phase II Icon Maps\Mud 5-1.mxd

Map By: CMP
MMI#: 5231-01-02
1st Version: 12/4/2013
Revision: 12/12/2013
Scale: 1 in = 1,333 ft

N

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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	$<2\ W_b$	$2\text{-}10\ W_b$	$>10\ W_b$

	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)

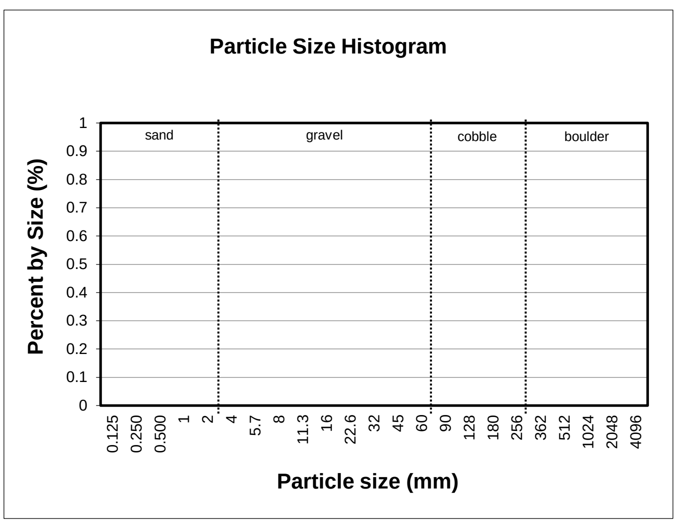
D (mm) of the largest mobile particles on bar

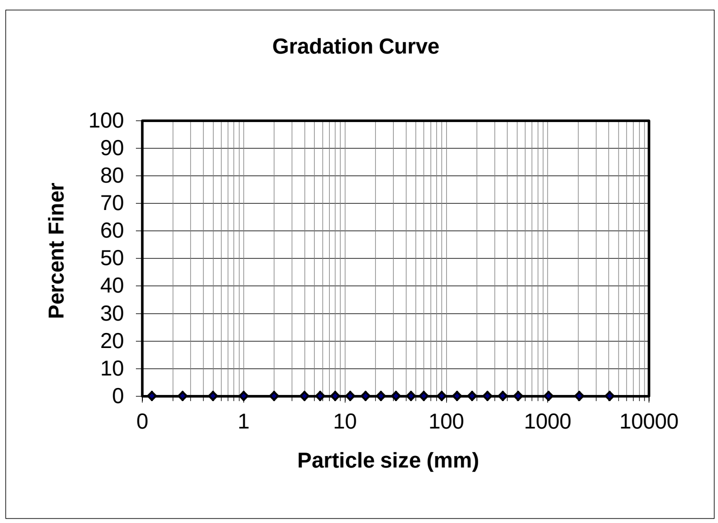
Mean	

Riffle Stability Index (%)

(Kappesser, 2002)

Notes





APPENDIX C

Mud Creek Photo Log

Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, Connecticut 06410
(203 271-1773

Mud Creek High
Photo Log

MMI# 5231-01
NYDOT
January 2014

PHOTO NO.: **1** DESCRIPTION: Looking upstream, here the main channel of Big Creek flows into the Middle Settlement Apartment complex.	
PHOTO NO.: **2** DESCRIPTION: Flowing through the center of the Middle Settlement Apartment complex, flood flows overtop the banks causing severe flooding to the residences.	

PHOTO NO.:

3

DESCRIPTION:

Shown is the upstream end of Seneca Turnpike (Route 5) culvert crossing.

PHOTO NO.:

4

DESCRIPTION:

Depicted is the downstream end of the Seneca Turnpike (Route 5) culvert crossing.

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PHOTO NO.: **5** DESCRIPTION: A stacked stone revetment wall in place adjacent to commercial buildings off of Commercial Drive.	
PHOTO NO.: **6** DESCRIPTION: Just east of Commercial Drive, this area becomes heavily flooded, incorporated into High Risk Area #3.	

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PHOTO NO.: **7** DESCRIPTION: Located just upstream of the Commercial Drive Crossing, this area experiences severe flooding during low frequency storm events.	
PHOTO NO.: **8** DESCRIPTION: Photo taken looking downstream from the Henderson Street Bridge.