LOCAL FLOOD ANALYSIS
FLOOD ENGINEERING ANALYSIS
AND HAZARD MITIGATION PLAN
TOWN OF ASHLAND
GREENE COUNTY, NEW YORK

Prepared for:

The Town of Ashland, NY
PO Box 129
Ashland, New York 12407

In partnership with:

Greene County Soil and Water Conservation District

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November 5, 2018

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Executive Summary

The Town of Ashland (Town) has been subject to numerous flooding events in its history, with at least 14 major events and millions of dollars of flood-related damage since the 1950s. No flooding event in current memory has been as destructive nor created as lasting a memory as Hurricane Irene in 2011 when 18 inches of rainfall was measured at Maplecrest, upstream of Ashland. This rainfall, and the ensuing flood flows, displaced numerous residents, caused the loss of a section of Route 23 towards Prattsville, and took one life near Maplecrest (AECOM, 2018). Hurricane Irene also had significant implications for the New York City Department of Environmental Protection (DEP) as numerous contaminants were introduced into the New York City water supply from flooding of residences, businesses, and agricultural areas.

Throughout the watershed of the New York City drinking water supply, which includes all of the Batavia Kill, DEP has partnered with local municipalities to develop Local Flood Hazard Mitigation Plans (LFHMP) for Designated Hamlet Areas identified in the New York City Watershed Memorandum of Agreement (City of New York et al., 1997). The goal of these LFHMPs is to identify and mitigate the flood hazards posed to public safety, private property, infrastructure, and the natural environment. Acting on behalf of the Town, the Greene County Soil and Water Conservation District (GCSWCD) has been funded by DEP to oversee the development of this LFHMP for the Batavia Kill within the Town limits (approximately from the Town's wastewater treatment plant to North Settlement Road). To lead the technical analyses and development of the LFHMP, GCSWCD contracted Woidt Engineering and Consulting, PC (WEC). A Flood Advisory Committee (FAC) composed of DEP, GCSWCD, and local community members was also formed to represent local and regional interests and provide direction to WEC during development of the LFHMP.

The first phase of the LFHMP process was to identify existing information pertaining to flood hazards in the study area. A Public Outreach Meeting was also held on December 13, 2017 to identify existing flood hazards and any additional anecdotal or technical data on flooding along the Batavia Kill. Following review of the collected data, which includes previous studies, engineering plans of recently-constructed projects, and flood documentation, WEC identified data gaps – missing information valuable to the study – and worked with GCSWCD to collect additional data to resolve the most significant data gaps.

After consolidating existing data and resolving critical data gaps, the next step in the LFHMP process was the development of a hydraulic model that could be used to quantify expected flood depths and the benefits of any proposed mitigation actions in reducing these flood depths. An existing model of the Batavia Kill prepared in 2004 for a Flood Insurance Study was identified. WEC reviewed both the hydrologic (how much water) and hydraulic (how deep the water is) aspects of this model. In its review of the model hydrology, WEC determined that the effective hydrology prepared in 2004 was still appropriate for use in the current study. From its updated hydrologic analyses, WEC also determined that Hurricane Irene was a very infrequent event, with an estimated annual chance of exceedance (ACE) of less than 0.2 percent, which corresponds to an average recurrence interval of more than 500 years. The rarity of this event was not unique to the Batavia Kill as can be seen in Figure ES-1, where the flows on Schoharie Creek were approximately twice that of any other event recorded since 1904.

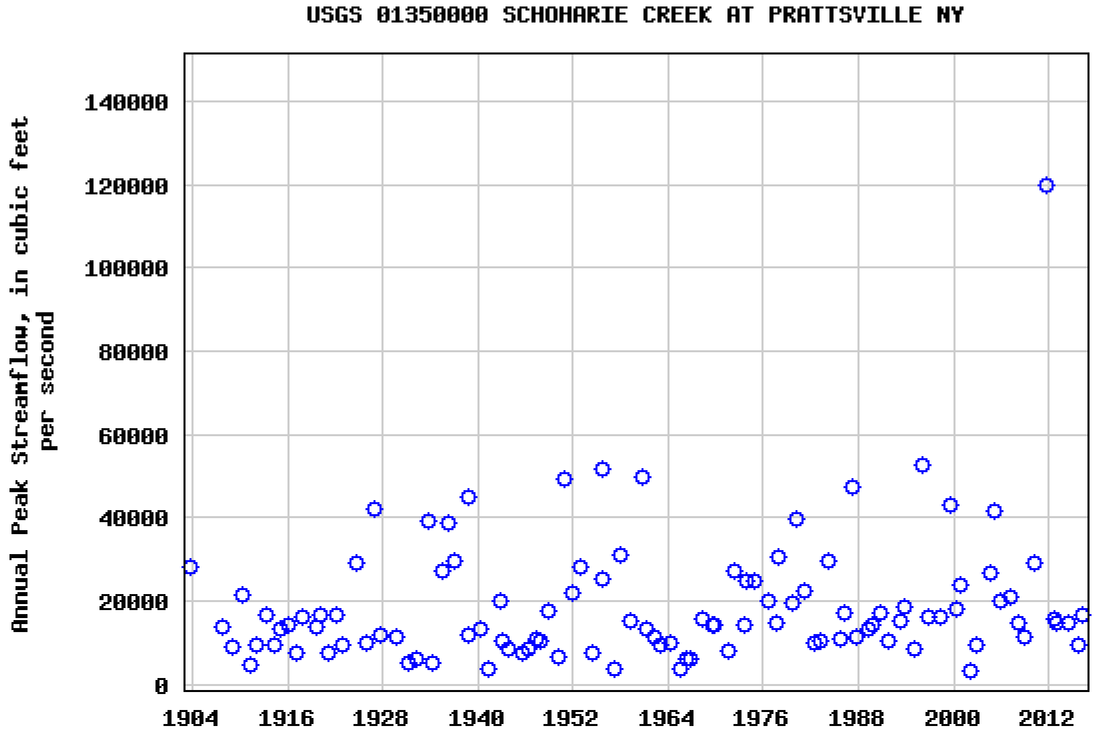

Figure ES-1. Annual Peak Discharges at Schoharie Creek at Prattsville (from USGS, 2018a)

After confirming the effective hydrology, WEC reviewed the hydraulic aspects of the effective model for use in the LFHMP. Based on the comparison of modeled water surface elevations to eyewitness accounts or post-flood measurements during and following Hurricane Irene and October 2010, WEC determined that the effective model over-estimated flood depths by approximately four to six feet within the study limits. So not to over-estimate flood depths or flood risk in the Town, WEC updated the model by incorporating recent projects along the Batavia Kill (County Road 17 and GCSWCD projects) and modified the model parameters until a satisfactory agreement between modeled and observed water surface elevations was achieved. This "Corrected Effective Model" was then used to affirm publicly-generated flood hazards, identify flood hazards not yet identified, and identify structures at greatest risk of flooding. The Corrected Effective Model estimated lower flood depths for the base flood than did the effective model used by FEMA to identify Special Flood Hazard Areas. This finding could be used as a rationale to advance a re-study of the Batavia Kill within the Town of Ashland, with the expected outcome that flood insurance premiums could be reduced to better reflect the lower level of flood risk estimated from the Corrected Effective Model. However, few, if any, structures would be anticipated to be removed from the regulatory floodplain altogether.

Following the quantification of existing flood risk, the next phase in the LFHMP process was the identification and analysis of potential flood mitigation actions to reduce flood risk to the Town and its residents, limit loss of community services and/or infrastructure, and protect water quality. A total of 14 potential alternatives were identified and reviewed by WEC, the FAC, the Town Board, and the local community. Table ES-1 summarizes the alternatives that were considered and whether hydraulic analyses or benefit-cost analyses were performed for the alternatives as part of this LFHMP.

Table ES-1
List of Preliminary Flood Mitigation Alternatives and Analyses Performed

Alternative ID	Alternative Description	Hydraulic Analysis Performed?	Benefit-Cost Analysis Performed?
1	Modification of WWTP discharge pipe	Yes	No
2	Gravel pit bridge improvement	Yes	No
3	Maier Farm bridge improvement	Yes	No
4	County Road 17 floodplain relief culverts	Yes	No
5	County Road 17 bridge widening and adjacent floodplain bench	Yes	Yes
6	Floodplain reclamation above WWTP	Yes	No
7	Floodplain bench near Ashland Town Park	Yes	No
8	Floodplain reclamation below Carrington Road	No	No
9	Relocation of Greene County Highway Garage	No *	Yes
10	Protective levee around Greene County Highway Garage and Winco Park	Yes	Yes
11	State Route 23 profile raise	No	No
12	Structure elevations	No *	Yes
13	Structure acquisitions	No *	Yes
14	Fuel Tank Anchoring	No	No **

* Benefit-cost analyses for these alternatives were dependent only on existing conditions
** Benefit-cost analyses have been performed by others separately from the LFHMP

WEC reviewed each of the potential alternatives summarized in Table ES-1 for its potential to reduce flood depths at occupied structures or public infrastructure. Hydraulic analyses were performed for most alternatives, unless it was apparent that little benefit would be realized or if there was a general lack of public support for the alternative. For those alternatives which hydraulic modeling indicated that flood depths would be significantly decreased at occupied structures or public infrastructure, or those alternatives that entailed the protection of such structures, cost-benefit analyses were performed. These cost-benefit analyses utilized estimates of future flood damage under existing and proposed conditions, with the "benefit" of the project being the difference between these two estimates of future flood damages. These benefits were then compared to the estimated cost of the project to determine a benefit-cost ratio (BCR). A project with a BCR of 1.0 would be a project where the benefits are exactly equal to the cost of the project. A project with a BCR greater than 1.0 would be considered cost-effective as the estimated benefits are more than the estimated costs. In contrast, a BCR of less than 1.0 would be expected to have fewer benefits than the cost of the project.

While cost-effectiveness is a key consideration in the potential funding of a project, it does not consider all the benefits of a project as many benefits are difficult to quantify as a dollar value. Therefore, WEC also completed a feasibility analysis that considered the technical feasibility of a project, its constructability, and its anticipated environmental and social benefits to develop a feasibility score for each project. Based on consideration of the project's BCR and feasibility score, WEC recommends the advancement of up to five potential mitigation alternatives summarized in Table ES-2 and detailed in Section 4 of the LFHMP:

Table ES-2
Prioritized List of Recommended Flood Mitigation Projects

Priority	Alternative	BCR	Feasibility Score
1	Alternative 9 - Relocation of Greene County Highway Garage	0.25	39
2	Alternative 14 – Fuel Tank Anchoring	> 1.0	38
3	Alternative 12 - Structure elevations [a]	Up to 1.29	37
4	Alternative 13 - Structure acquisitions [b]	Up to 1.26	34
5	Alternative 4 - County Rd 17 floodplain relief culverts [c]	0.29	34

Based on cost-benefit analyses, WEC determined only three alternatives were cost-effective: Alternative 12, 13, and 14: the elevation and acquisition of structures as well as the anchoring of fuel tanks. Specific properties with favorable BCRs for acquisition or elevation have been identified to the Town Board and pending property owner concurrence, are recommended for advancement. WEC also recommends immediate anchoring of fuel tanks given the benefits of this action and the immediate availability of funding to eligible residents (see Section 4.15 for details).

Pending detailed feasibility assessments, several funding sources are available for the alternative identified in Table ES-2. Of the two community-scale alternatives recommended for advancement, WEC has recommended Alternative 9, at a cost of $1.5 to $5.8 million, as the top priority given that the Greene County Highway Garage has flooded three times since 1996 and provides a critical function during flood events. Protection of this critical community facility by relocating it entirely out of the floodplain should be a top priority for the Town, although funding sources are limited given its low cost-effectiveness by traditional cost-benefit analyses. Alternative 4, at a cost of $190,000 to $760,000, has also been recommended, but only to potentially supplement other funding sources that may seek to implement the alternative for environmental or other reasons.

While there are five flood mitigation alternatives for the Town to consider, and only three which are cost-effective, WEC considers these results to be a manifestation of there being relatively little flood risk in the Town to mitigate (compared to other municipalities) rather than a lack of cost-effective solutions. This opinion is somewhat validated by the fact that despite the historic precipitation and stream flow observed during Hurricane Irene, flood damage within the Town was significantly less than what other similar-sized upstate New York communities have experienced in the last decade. The fact that there has only been a few million dollars' worth of damage in three-quarters of a century reinforces that multi-million-dollar community-scale flood mitigation alternatives are likely not cost-effective; rather, actions should be focused on a subset of individual properties and community-scale outreach projects to mitigate future damage. Overall, these results suggest that development within the Town has been responsibly done and WEC recommends continuation of existing land use practices that have generally located structures outside, or elevated well-above, the base flood while maintaining the most flood-prone properties for agricultural or conservation uses.

1.0 Introduction

1.1 Background

The Town of Ashland (Town) has been subject to numerous flooding events in its recent history. Each of these flooding events have damaged private property, public infrastructure, and resulted in costly damages to private owners and government entities. Since 2009, over $350,000 of flood insurance claims have been filed for and paid out to private property owners in the Town of Ashland (AECOM, 2018). These figures do not include the cost incurred by local municipalities, utilities, or New York State to restore services, repair damaged infrastructure, and provide support to displaced residents, nor do they include lost wages due to forced closure of local businesses. It is predicted that in the event of a 100-year flood, up to $2.5 million of damage to residential buildings within the Town may occur (AECOM, 2018).

The threat to the Town and its residents posed by flooding became a reality in August 2011 when Hurricane Irene (then a Tropical Storm) made landfall in downstate New York and traversed the eastern part of the state over a period of a few days. As a result of extreme rainfalls, including over 18 inches in upstream Maplecrest, widespread flooding occurred. Statewide, a total of 31 New York counties were declared Federal disaster areas as a result of Hurricane Irene. Damages in New York alone exceed $1.3 billion dollars and 10 deaths were attributed to the storm (Lumia et al., 2014).

Locally, flooding caused by Hurricane Irene forced the evacuation of numerous residents in the towns of Ashland, Windham, and Prattsville (AECOM, 2018). Several displaced residents found shelter in the town hall until it was safe to return to their residences. Following the storm, damage to one residence on State Route 23 was so extensive that owners chose to accept a buyout from FEMA and their property has since been demolished and conveyed to the Town. Numerous local roads in addition to portions of State Route 23 were closed as floodwaters inundated roadways, preventing emergency responders from accessing some affected residents. In the hamlet of Maplecrest, one death was reported as a woman drowned in her house as floodwaters swept the house downstream. 18,000 residents of Greene County were without power as the result of wind and flood damage to electric infrastructure (AECOM, 2018). Erosion along the Batavia Kill also isolated some residents as private bridges were washed out. Eroded soils, many of which were productive agricultural soils, led to the loss of private property. Eroded soils were either deposited locally in the Batavia Kill, which in some cases re-directed flows and triggered additional erosion, or these eroded sediments were washed downstream. Sediments transported downstream ultimately impaired the water quality of Schoharie Reservoir, a key drinking water source for New York City. Household chemicals and other pollutants were also swept away during the flood and caused both environmental and human health concerns downstream of Ashland.

1.2 Study Purpose

To identify and mitigate the hazards posed to public safety, private property, infrastructure, and the natural environment by flooding, the New York City Department of Environmental Protection (DEP) has funded the Greene County Soil and Water Conservation District (GCSWCD), acting on behalf of the Town, to oversee the development of this Local Flood Hazard Mitigation Plan (LFHMP). The first milestone of the LFHMP process is to review existing information and solicit local knowledge to identify existing flood hazards within the Town and develop a functional computer model that quantifies the frequency of how often identified flood hazards occur, on average. Examples of flood hazards include the following:

- **Riverine Flood Hazard** - A location where overflow from a river, stream, or creek damages assets and often results in a federal disaster declaration. This type of flooding generally occurs more than six hours after peak rainfall.
- **Flash Flood Hazard** - A location where a rapid and extreme flow of high water overflows from a river, stream, or creek channel into a normally dry area beginning within six hours of an intense rainfall event. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters, i.e. a minor flooding event rapidly becomes a larger flooding event after another burst of intense rain.
- **Stormwater Flood Hazard** - A location where damage to assets occurs resulting from insufficient capacity of private or municipal stormwater drainage infrastructure. This includes ditches, catch basins, and piping systems.
- **Debris Jam Flood Hazard** - A location where damage to assets occurs resulting from flooding or erosion that is caused by debris reducing the capacity of water corridors, bridges, culverts, or stormwater drainage infrastructure. Debris can be wood, bedload (i.e., river stones moved by water in streams), or manmade (e.g., sofas, car parts).
- **Erosion Hazard** - Eroding Banks that threaten public or private infrastructure. Threatened infrastructure is near an actively eroding bank (notable movement of bank over the last five years) and the rate of erosion could threaten infrastructure within the next five years.
- **Ice-Jam Flood Hazard** - A location where damage to assets occur resulting from flooding or erosion caused by ice jams. An ice jam is an accumulation of ice that acts as a natural dam and restricts flow of a body of water. Ice jams may build up to a thickness great enough to raise the water level and cause flooding.
- **High Groundwater Level Flood Hazard** - An area where damage occurs in areas not connected to recognizable drainage channels. Such areas occur from a combination of infiltration and surface runoff (sheet flow) where water may accumulate and cause flooding problems generally in concave basins.
- **Unknown Flooding Hazard** - The cause of flooding is not known.

Following identification of potential flood hazards, the next milestone in the LFHMP process is to work alongside the local community to develop potential projects to mitigate the identified hazards and provide ancillary benefits. A Flood Advisory Committee (FAC) consisting of local community members, GCSWCD, and DEP was formed to represent the interests of the local community and lead greater community engagement. The FAC was integral to the process of developing viable potential flood mitigation projects. Ideally, each of the potential mitigation options will be developed to provide the following ancilliary benefits:

- Maintaining and improving the safety of Ashland's residents and visitors;
- Reducing repetitive flood damage to buildings and public infrastructure;
- Limiting disruption of community life during repairs and clean-up;
- Reducing the cost of flood insurance (required by mortgage lenders) that becomes an economic burden on individual property owners, thereby reducing property values and driving some businesses to close; and,

- Protection of water quality and natural resources (e.g., reducing repetitive flooding of a gas station would also reduce the frequency contaminants runoff into local streams or reducing erosion flood hazards would reduce the introduction of fine sediments to streams that may impair drinking water quality).

Following development of potential mitigation alternatives, the LFHMP is structured to objectively analyze the benefits of specific projects and projects in combination. The goal of this analysis is to identify and advance the projects that most cost-effectively reduce flood damage, improve the community, and enhance the environment. A collaborative relationship between flood mitigation experts and the local community is paramount to ensuring that:

- Solutions are cost-effective for the Town to build and to maintain;
- Solutions are cost-effective for individuals and businesses directly involved;
- Solutions maintain, as much as possible, the sense of community and the "flavor" of businesses and residential areas;
- Solutions are accepted by the community as realistic and desirable; and,
- Solutions protect natural resources, especially the streams and wildlife.

Following the objective analysis and incorporation of local input on the potential alternatives, the LFHMP will document the solutions considered and technical analyses and community input that rationalizes the advancement or non-advancement of specific alternatives. The LFHMP will then prioritize the cost-effective, community-supported projects into an actionable plan that the Town and Greene County can use to prioritize and procure funding for flood mitigation projects.

1.3 Scope

Throughout the watershed of the New York City drinking water supply, DEP has partnered with local municipalities to develop LFHMPs for Designated Hamlet Areas identified in the New York City Watershed Memorandum of Agreement (City of New York et al., 1997). The scope of the current LFHMP is limited to the Batavia Kill in the Town of Ashland, in Greene County, New York. The study limits are identified in Exhibit 1-1 and generally include the areas identified in the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area from a point approximately 500 feet downstream of the Town's wastewater treatment plant upstream to the intersection of North Settlement Road and State Route 23. If significant costs of damages have occurred in other portions of the Town of Ashland, DEP reserves the right to expand the study boundary.

The project study area is within the watershed of DEP's Schoharie Reservoir, a key drinking water supply for New York City. Since 2003, DEP has been working alongside GCSWCD to develop and implement the Batavia Kill Stream Management Plan (SMP). The SMP is a managerial document that guides activities to stabilize stream corridors, enhance the ecology of stream corridors, and improve water quality. While the SMP was not explicitly developed as a flood damage mitigation plan, several of the actions identified in the SMP would help to mitigate future flood damage along the Batavia Kill. Therefore, the LFHMP was developed to complement and build upon the Batavia Kill Stream Management Plan and specifically advance the identification of potential flood mitigation projects.

It should also be noted that LFHMPs have been developed for adjacent communities along the Batavia Kill. For residents interested in LFHMPs for the adjacent communities of Windham and Prattsville, LFHMPs can be accessed via the following links:

Town of Prattsville: http://catskillstreams.org/wp-content/uploads/2015/01/LFA_Prattsville.pdf
Town of Windham: http://catskillstreams.org/wp-content/uploads/2015/01/LFA_Windham1.pdf

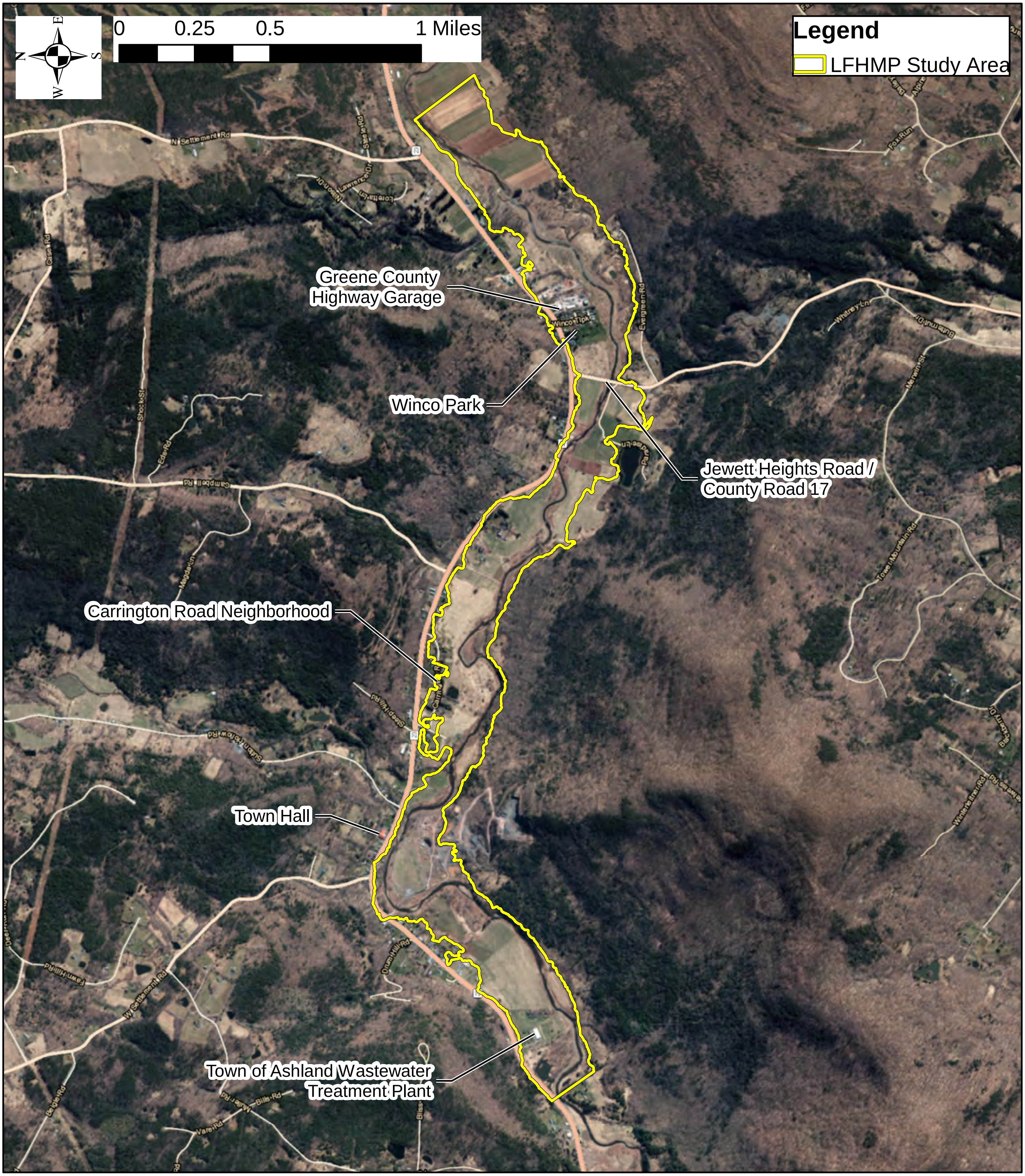

EXHIBIT 1-1 PROJECT STUDY AREA

PROJECT INFORMATION:

Local Flood Hazard Management Plan
Town of Ashland, NY
August 17, 2018

PREPARED BY:

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F:\Dropbox\Woidt\Engineering Projects\2016 EP\NY E042.2016 Town of Ashland LFA\ArcGIS\mxd\LFHMP\Exhibit1.1-StudyArea.mxd 8/20/2018 12:32:13 PM;

2.0 Data Summary and Gaps Analysis

2.1 Existing Resources

Prior to collecting new data for the LFHMP, WEC reviewed existing resources to identify where existing data can be used to meet the data needs of the LFHMP. A summary of the existing resources collected for the LFHMP are summarized in Table 2.1. Detailed discussion of existing resources identified in Table 2.1 that were used in the study are provided in subsequent sections.

Table 2.1
Summary of Existing Data Used in the Ashland LFHMP

Data	Source	Description
Aerial Imagery	NYSGPO, 2018	2016 Half-foot resolution orthoimagery from NYS GIS Clearinghouse
Batavia Kill Effective Model	NYSDEC, 2004	Effective hydraulic model used to develop FIRMs for Batavia Kill in the Town of Ashland
Batavia Kill Stream Management Plan	GCSWCD, 2003	Geomorphic assessment and mitigation plan to protect and improve the geomorphic function of the Batavia Kill, with the primary goal to reduce erosion and turbidity at NYCDEP reservoirs.
Batavia Kill Stream Restoration As-Built Plans	GCSWCD, 2017	As-built AutoCAD Civil3D surfaces for stream restoration projects completed by GCSWCD
Greene County Flood Insurance Study	FEMA, 2015a	Summary documentation of previous studies used to identify flood hazards and develop Flood Insurance Rate Maps in Greene County.
Greene County Hazard Mitigation and Resilience Plan	AECOM, 2018	Multi-jurisdictional document identifying potential hazards and proactive mitigation solutions to reduce the impacts of natural hazards, including flooding.
Greene County Highway Department Assets	Greene County, 2018a	Detailed inventory of vehicles and equipment stored at Greene County's Highway Garage in Ashland
Greene County Webmap	Greene County, 2018b	GIS data including approximate tax parcels, total assessed value, and assessed land value.
High Water Marks	GCSWCD, 2010	High water marks observed in 2010 as part of existing conditions analysis for Holden project.
Ice Jam Database	USACE, 2018	GIS data documenting historic and current locations of ice jams in the United States.
Jewett Heights Road (CR17) over Batavia Kill As-Built Plans	Clark Patterson Lee, 2014	As-built documentation of CR17 bridge replacement over the Batavia Kill
Observed Peak Discharges	USGS, 2018a	Observed peak discharges at Batavia Kill stream gages operated by the USGS
National Flood Hazard Layer	FEMA, 2015b	Digital file providing the geographic extents of special flood hazard areas delineated by FEMA.
Town of Ashland WWTP HEC-RAS	WEC, 2011	Post-development hydraulic model for construction of Town of Ashland Wastewater Treatment Plant
West of Hudson Lidar	NYSGPO and NYCDEP, 2009	2m lidar collected for the West of Hudson Watershed in 2009.

2.2 Public Outreach

2.2.1 December 13, 2017

In addition to reviewing existing resources, WEC also solicited local knowledge from the FAC, Town Board, and local community in a series of meetings. On December 13, 2017, WEC participated in a workshop with the FAC and moderated a public meeting immediately afterward to solicit local knowledge to identify existing flood hazards within the Town of Ashland. To facilitate discussions, maps of the LFHMP study area were printed to allow participants to identify flood locations within the study area. Tables were also created that were used to collect the following information about each flood hazard: hazard type, frequency of hazard occurrence, date of hazard occurrence (if applicable), and the hazard's impact to the participant and the hazard's impact to the community.

While only one community member attended the public meeting, low turnout did not limit the value of the local knowledge conveyed by this community member and the FAC. Through the public meeting and meetings with the FAC and Town Board, a total of 18 flood hazards and/or potential areas of concern were identified. The majority of submitted hazards were directly related to riverine flooding, but a few erosion hazards and deposition hazards were also submitted. The location and type of flood hazards identified by the FAC and general public are summarized in Exhibit 3A to 3F of Appendix A; brief descriptions of the flood hazards are also included with the flood hazards.

2.2.2 June 7, 2018

A second public outreach meeting was coordinated by GCSWCD and held at the Ashland Town Hall on June 7, 2018. The purpose of this public outreach meeting was to solicit public input on the existing condition analyses, the developed flood mitigation alternatives, and the calculated benefits of the proposed flood mitigation alternatives. Attendance for this meeting was also limited, with only two attendees beside those from GCSWCD and WEC. However, Tom Hoyt, deputy superintendent of Greene County Highway Department, attended and provide valuable information related to potential flood damages and mitigation projects related to the Greene County Highway Department Garage.

2.3 Data Collection

Following collection of existing resources and local knowledge from LFHMP participants, WEC reviewed the available data to identify preliminary data gaps related to completing the LFHMP. These preliminary data gaps were then used to inform the field data collection efforts to complete the LFHMP. In general, the preliminary data gaps were detailed technical information particular to flood mitigation studies that are not frequently available through other resources.

To address these preliminary data gaps, WEC staff reached out to local municipal resources to confirm that data is not already available and then completed both remote and field-based investigations to develop the remaining data. WEC's field work for the project was completed on Wednesday, February 28, 2018. Conditions on this date were unseasonably warm and the snowpack was thin, allowing good access throughout the study area and a good view of the micro-topography and vegetation along the Batavia Kill and its floodplain. The information collected by WEC during this field visit are summarized in Table 2.2 on the following page.

Table 2.2
Preliminary Data Gaps Resolved Through Remote and Field Investigations

Preliminary Data Gap	Importance of Data Gap	Data Collected to Resolve Data Gap
Finished floor elevation (FFE)	Flood elevation in relation to FFE is important predictor of flood damage costs.	WEC field staff approximated the height of the FFE above adjacent low-ground for flood-prone properties. FFE calculated as this difference plus low ground elevation from lidar.
Hurricane Irene High Water Marks	Used to validate accuracy of hydraulic model.	Interviews with local property owners who identified depth of flooding on their property in 2011.
Water Quality Hazards	Flood hazards that have a short- and long-term impact on downstream communities by impairing water quality.	WEC field staff reviewed the study area and identified non-residential potential sources of contamination such as automotive repair garages, material storage yards, commercial oil tanks, and laundromats.

2.4 Data Gap Analysis

While the science of hydraulic modeling has advanced to a point that reliable, actionable results are feasible for a modest budget, it is important to note that there is always an inherent uncertainty in the study of natural systems and their impact on the built environment. Many of the sources of natural uncertainty are apparent: weather variability (e.g., small storms vs. large storms), changes in hydraulic roughness (e.g., leaf-out), and snowpack can all impact the extent of flooding for a particular storm event. Less-apparent sources of natural uncertainty can also affect the extents of future flooding such as long-term climactic trends (e.g., increasing frequency of large storms) and natural channel processes (e.g., erosion and sedimentation). Similar to natural events, anthropogenic changes can also introduce uncertainty into the understanding of flood impacts: future development trends, construction in the floodplain (both permitted and unpermitted), changes to hydraulic roughness (e.g., fallowing a field for a season), and future property values will affect both the extents of flood event and the subsequent damages to the community. Therefore, to make informed decisions based on the results of the LFHMP, it's important to understand both the information used to develop the LFHMP and the information that would improve the study but was not available.

An increasingly common approach to identifying the uncertainty in a study is to perform a data gaps analysis. The goal of the data gaps analysis is to identify potential gaps in the available data that if resolved, would improve the accuracy and/or decision-making process for the study. It's important to note that not all data gaps can be resolved; in some cases, the data simply does not exist at the present. In other cases, resolving the data gap may be cost-prohibitive in relation to the approximate value of resolving the data gap. Table 2.3 summarizes the potential data gaps related to the LFHMP and includes both those identified by WEC, the FAC, and the general public.

Table 2.3
Summary of Remaining Data Gaps for the Ashland LFHMP

Identified Data Gap	Example Impact of Data Gap	Example of Additional Data Needed to Resolve Data Gap
Adaptation of Flood-Damage Curves to Individual Properties	Nationally-developed flood-damage curves have been justified for large flood studies. However, flood damages will vary for an individual property owner based on their unique structure and where valuables are stored.	Receipts of incurred flood damages from 2011 or other flooding events.
Future Development and Property Values	Increased floodplain development and/or property values would increase the potential damages following a flood and also increase the benefit of mitigation.	Comprehensive community planning and/or economic studies can provide estimate of future development, but are only predictions.
Hydraulic Impact of 2011 Erosion and Deposition	Validation of hydraulic model to 2011 High Water Marks is based on available topography; flood-induced erosion and deposition may impact water surface elevations.	N/A. Detailed review of available photographs may identify locations of erosion and deposition, but occurrence in relation to flood peak could only be approximated via observations or more detailed modeling.
Hydraulic Impact of CR 17 Bridge	Modeled 2-feet rise near CR-17 is particular contribution to flooding of Winco Park and Greene County Highway Garage. Impact of bridge, abutments, and/or floodplain is uncertain due to potentially outdated topography.	Detailed breakline survey of revised CR-17 bridge, approaches, abutments, and floodplain topography to improve representation in hydraulic model.
Long-term Gage Record	Gage record at Batavia Kill streamgages is relatively short (approx. 20 years) and may not be representative of long-term distribution of flooding.	Additional measurement and collection of annual peak discharges at USGS gaging stations.
Natural Water Quality Hazards	Composition of streambanks will affect whether streambank erosion is a potential source of water quality hazards. Clays and other fine particles that tend to not settle out would be greater hazards to drinking water	Grain size distribution and sediment quality testing of streambanks to assess physical and chemical composition. BSTEM analysis to assess erodibility.
Natural Climate Variability	BCAs are based on the statistical probability of a flood event occurring. However, it is possible that an event with a 1 percent chance of occurring can occur in back-to-back years. In such a case, actual flood damages would exceed those predicted. The converse is also true.	N/A. Occurrence of floods cannot be predicted more than a few days in advance.

Table 2.3
Summary of Remaining Data Gaps for the Ashland LFHMP

Identified Data Gap	Example Impact of Data Gap	Example of Additional Data Needed to Resolve Data Gap
Residential Water Quality Hazards	Water quality hazards at residential properties vary depending on heating system, use of household chemicals, and where such chemicals are stored within the house and/or outbuildings.	Detailed survey of heating systems and elevations in relation to first-floor elevations. Identification of unusual chemicals of concern at individual properties.
Surveyed High Water Marks	Available high water marks for 2011 flood are approximate only; increased accuracy of high water marks may affect calibration of floodplain.	Indicators of 2011 high water marks are likely no longer available. Surveyed high water marks would require another large flood event.
Updated Bathymetry and Floodplain Topography	Channel and floodplain changes since 2004 may impact the conveyance and resulting depth of flooding.	Re-survey of existing channel and incorporation of NYSGPO 2009 lidar or newer lidar.

3.0 Existing Conditions

3.1 Batavia Kill Watershed

3.1.1 Topology

A watershed is defined as the total area of land that drains to a specific point. The size, shape, climate, soils, and land use of a watershed are key controls that directly impact the degree to which rainfall is absorbed into underlying soils or runs off to increase downstream flows (and in turn, flooding). At the downstream boundary of the study area, the total contributing drainage area of the Batavia Kill shown in Exhibit 3-1 is approximately 62 square miles (USGS, 2018b). The watershed is generally oriented in an east-west direction, parallel to the Batavia Kill, with one principal valley along the Batavia Kill. The watershed is generally asymmetric, with steep hillslopes on the south side of the watershed draining near-directly to the Batavia Kill. On the north side of the watershed, steep hill slopes drain directly to the Batavia Kill or to minor tributaries which then confluence with the Batavia Kill. The steeper slopes of the Batavia Kill generally decrease the opportunity for precipitation to pool and absorb into underlying soils, increasing runoff in comparison to flatter watersheds. In addition, the steep slopes and channels also increase the risk of flash flooding as runoff is rapidly conveyed down steep streams to populated areas of the watershed.

3.1.2 Geology and Soils

The watershed of the Batavia Kill is located in the Catskill Mountains physiographic province. This province is generally characterized as mountainous, upland topography with deep valleys derived from glaciation and fluvial incision into underlying bedrock which is generally composed of stratified sandstones and shales, with an erosion-resistant conglomerate cap at high elevations (NYSDOT, 2013). Watershed soils derived from the erosion and weathering of the underlying geology generally have moderate to poor permeability, with over 90% of soils in the watershed having a slow or very slow infiltration rate (GCSWCD, 2003). As a result, watershed soils generally have a low capacity to absorb precipitation, leading to greater quantities of runoff following a storm event. In combination with the aforementioned steep slopes, the watershed is generally considered to be sensitive to rainfall – small amounts of rainfall will generate quick and significant changes in river flows.

3.1.3 Land Use

At the present, the watershed is generally rural, with principal land uses of forestry (80%) and grassland (19%). Areas of higher population density exist in the valley bottoms adjacent to the watersheds streams and flood damage is an increasingly frequent occurrence in the watershed. Total impervious area, which completely obviates the ability of underlying soils to absorb runoff, in the watershed is less than 1% (GCSWCD, 2003). At the watershed scale, the generally natural conditions provide a greater capacity to absorb rainfall (e.g., on leaves of trees) and retain rainfall (e.g., by transpiration or storage in micro-topography created by tree roots). However, it is important to note that while relatively healthy today, past disturbances of the watershed such as clearing in the 1800s can affect runoff processes today. For example, clearing may have increased hillslope erosion and decreased the depth of soil cover available to absorb rainfall (Wohl, 2001).

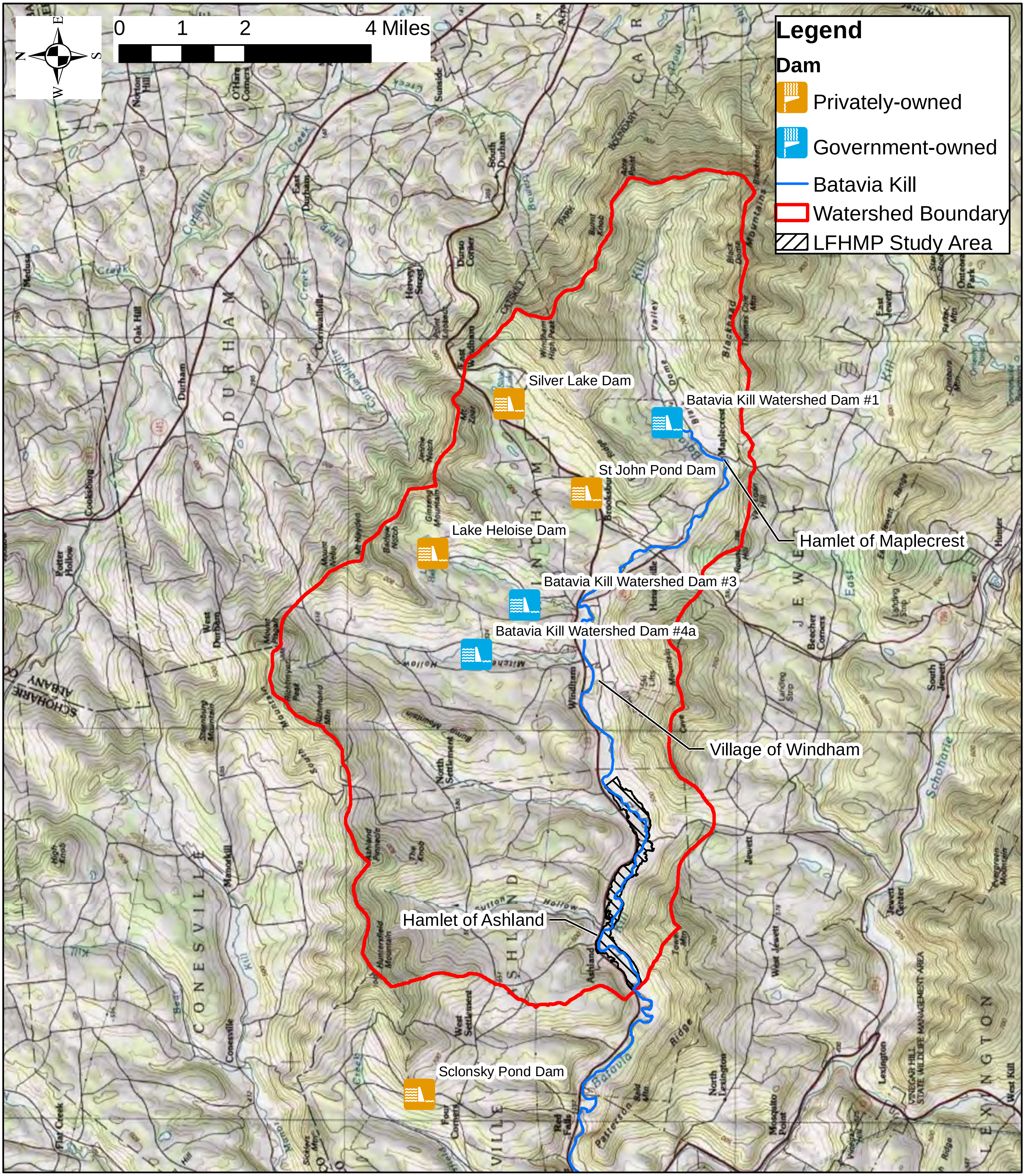

EXHIBIT 3-1 BATAVIA KILL WATERSHED AT STUDY AREA

PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland, NY
Octber 29, 2018

PREPARED BY:

Woidt Engineering & Consulting, P.C.
11 South Washington Street
Binghamton, New York 13903
www.woidtengineering.com

F:\Dropbox\Woidt\Engineering Projects\2016 EP\NY E042.2016 Town of Ashland LFA\ArcGIS\mxd\LFHMP\Exhibit3-1-Watershed.mxd 10/29/2018 6:07:55 PM;

3.1.4 Climate

Long-term average precipitation in the Batavia Kill watershed is approximately 43 inches but increases to as much as 51 inches at the highest elevations (GCSWCD, 2003). These high elevations contribute to a phenomenon known as orographic uplift in which air is forced higher into the atmosphere, which is generally cooler. If humid air is cooled, precipitation is formed, leading to increased precipitation at higher elevations. This trend can also be noted during individual storm events – the largest rainfall depths during Hurricane Irene were measured along the highest elevations separating the Schoharie Creek watershed from that of the Hudson River (approximately the boundary between the towns of Windham and Durham). While rainfall is the dominant cause of flooding in the watershed, snowpack can have an effect on flooding as occurred in 1996 when a rain-on-snow event caused flooding along the Batavia Kill (GCSWCD, 2003). It is also important to note that by calculating the difference in average precipitation and snowfall between the 30-year periods ending in 2000 and 2010, the Northeast Regional Climate Center has measured a general increase in annual precipitation of 1.5 inches and a decrease in snowfall of approximately 4 to 6 inches. This general trend of increasing precipitation, with a greater proportion occurring as rain rather than snow, may suggest an increased risk of flooding in the future. Supporting this suggestion is, that based on observations of measured rainfall, there has been a 70 percent increase in precipitation occurring as part of "very heavy events" between 1958 and 2010 (Karl et al., 2009).

3.1.5 Water Resources Infrastructure

Following significant flood events in 1955 and 1960, the Batavia Kill Watershed District with support from the Natural Resource Conservation District constructed three dams for the primary purpose of flood control. The locations of these three dams and their respective drainage areas are identified in Figure 3-2. While other dams are located in the watershed, these three structures were built specifically for flood control. Each was designed to store up to an event with an annual chance probability of occurrence on 1 percent (i.e., a 100-year flood). The dams are well-managed and functioning and mitigate some of the runoff characteristics of the naturally steep topology by attenuating (temporarily storing water for later release) and slowing down runoff (GCSWCD, 2003).

3.1.6 Geomorphic Setting

In the study of flood hazards, it's important to understand how the specific stream segment relates to the overall watershed. Figure 3-3 provides the longitudinal profile of the Batavia Kill from the watershed divide above Maplecrest to the confluence with Schoharie Creek, near Prattsville. This longitudinal profile demonstrates the change in elevation over distance along the valley of the Batavia Kill and provides an indirect assessment of the energy potential of the valley segments. At steeper slopes, water will move faster and have more energy. This energy is expended by turbulence induced by the channel bed, channel banks, and other roughness features of the channel. It can also be expended by mobilizing natural sediments along the channel bed, natural debris (e.g., wood), and artificial debris.

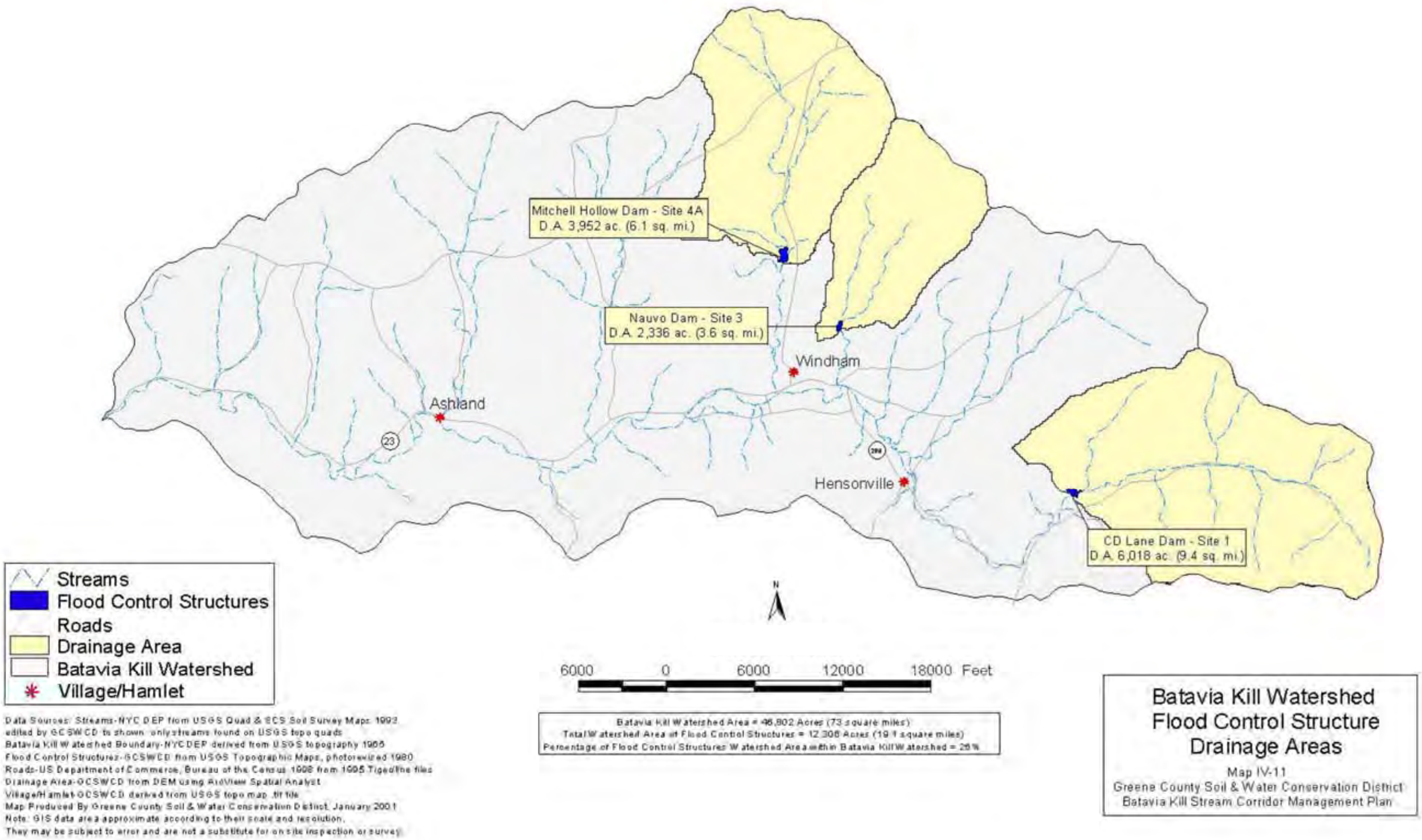

Figure 3-2. Batavia Kill Watershed District Flood Control Dams (from GCSWCD, 2003)

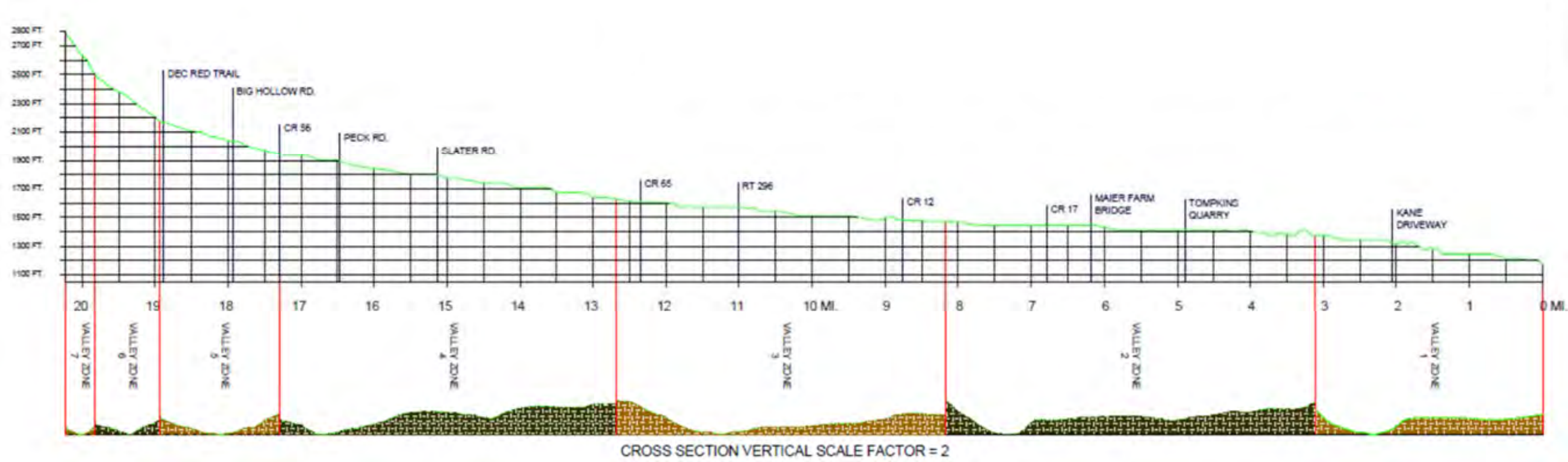

Figure 3-3. Longitudinal Profile of Batavia Kill (from GCSWCD, 2003)

Of particular importance, the study area is located within "Valley Zone 2", which is the lowest gradient segment of the entire Batavia Kill. This reach is generally expected to have lower capacity to transport debris and sediment. Deposition is expected at the transition to this valley type as the capacity of the Batavia Kill is not sufficient to mobilize large sediments or wood conveyed into the study area by higher-energy, upgradient areas. Evidence of this depositional tendency can be observed near the confluence of North Settlement Creek at the upstream end of the study area where deposition has caused frequent channel meandering, avulsion, and erosion, each of which can contribute to flood hazards in this reach of the Batavia Kill.

3.2 Flood History

Flooding along the Batavia Kill has and can occur in any month of the year; Table 3-1 summarizes major floods recorded in Greene County. However, the majority of significant damage-causing floods have occurred as the result of rain-on-snow events where snowmelt, which saturates underlying soils and increases stream flows, is followed by a significant rainfall. Eight of the eleven largest events recorded at the US Geological Survey's (USGS) Schoharie Creek at Prattsville, NY, which has a gage record extending back to 1904, were the result of such events (FEMA, 2015a). However, tropical storms, including hurricanes, in late summer and early fall are also a principal source of flooding on the Batavia Kill. Of the three highest flows recorded since 1996 at the USGS's Batavia Kill at Red Falls gage, the two highest (1999 and 2011) are the result of hurricanes or tropical storms (USGS, 2018a), with Hurricane Irene producing the most significant runoff and damage in the Town of Ashland. The third, the January 1996 flooding event, occurred as the result of a rain-on-snow event (FEMA, 2015a).

Table 3-1
Major Floods in Greene County (from AECOM, 2018 and GCSWCD, 2003)

Date of Event	Type of Event	Approximate Loss*
Nov 1950	Unknown (presumed hurricane)	Unknown
Aug 1955	Hurricane Connie	Unknown
Oct 1955	Unknown (presumed hurricane)	Unknown
Sept 1960	Hurricane Donna	$750,000 (Ashland)
Apr 1987	Snowmelt followed by rain-on-snow	$2,000,000
Jan 1996	Nor'easter followed by rain-on-snow	$10,000,000
Sep 1999	Hurricane Floyd	$3,000,000
Sep 2000	Severe storms	$115,000
Aug 2003	Severe storms	$75,000
Apr 2005	Severe storms	$1,300,000
Jul 2006	Severe storms	$700,000 in individual assistance
Apr 2007	Nor'easter	$111,000,000 in individual assistance
Aug 2011	Hurricane Irene	Unknown
Oct 2012	Hurricane Sandy	$384,000

* For Greene County, unless noted otherwise.

3.3 Hydrologic Analysis

3.3.1 Verification of Effective Hydrology

While the FIS makes mention of the 2011 Hurricane Irene flooding event in the Schoharie Creek watershed, which the Batavia Kill is a part of, it does not use data from the flood to adjust or calibrate flows and/or water surface elevations for the modeling efforts. Therefore, the effective hydrology for the Batavia Kill does not incorporate the best available data and could possibly misrepresent the flood frequencies along the Batavia Kill. As such, WEC performed a new hydrologic analysis to estimate the flood frequency of the Batavia Kill in the study area based on available stream gage data at the Red Falls stream gage, which includes a measurement of peak discharge during Hurricane Irene. In addition to including data from Hurricane Irene, the updated analysis also includes other years of peak discharge observations that were unavailable when the FIS study was completed.

The new hydrologic analysis utilized procedures recommended in the April, 2017 draft of Bulletin 17C: Guidelines for Determining Flood Flow Frequency (England et al., 2017). Bulletin 17C includes key improvements from its predecessor, Bulletin 17B, particularly the use of the Expected Moments Algorithm which is statistically superior and better suited to incorporate historic data, missing data, outliers, and uncertainty than the Bulletin 17B procedures. For a gage with only a systematic record, Bulletin 17C analyses will yield identical results as to Bulletin 17B. WEC used the US Army Corps of Engineers' (USACE) Hydrologic Engineering Center's Statistical Software Package (HEC-SSP), version 2.1 (Bartles et al., 2013) to perform the Bulletin 17C analysis. Systematic annual peak discharges at the USGS's Batavia Kill at Red Falls near Prattsville, NY (USGS Gage No. 01349950) were downloaded from the USGS's National Water Information System (USGS, 2018a) and input into HEC-SSP. Table 3-2 summarizes key statistics and parameters for the Red Falls stream gage.

Table 3-2
Summary of Key Parameters at Red Falls Stream Gage

Parameter	Quantity
Drainage Area	68.6 mi
Period of Record	1996 to current
Years of Record	21
Peak Discharge	44,200 ft^3/s
Date of Peak Discharge	August 28, 2011
Station Skew	0.56
Generalized Skew	0.18
Weighted Skew	0.33

To fit a statistical distribution to a given dataset, such as annual peak discharge estimates, a skew coefficient is used to quantify the asymmetry of the dataset. For datasets with the same average value, the statistical distribution with the greater skew coefficient would yield a higher estimate of a given rare event (i.e., the "big" events are "bigger"). Skew coefficients can be estimated either from the measured data at the stream gage (station skew), a representative value derived from station skews from the surrounding area (generalized skew), or a combination of the two (weighted skew).

A weighted skew was used in the analysis of the stream gage to adjust the calculated station skew to integrate regional skew statistics of surrounding stream gages. The generalized skew and mean-squared error to weight the station skew were adopted from New York-specific data developed by Lumia and Baevsky (2000). The USGS's National Streamflow Statistics Program, version 6.1 (USGS, 2007) was used to weight and transform the resulting Bulletin 17C estimates per the procedures recommended by Lumia et al., 2006. Table 3-3 provides both the effective and calculated peak discharges for the 50-, 10-, 4-, 2-, 1-, and 0.2 percent Annual Chance Exceedance (ACE)[1] discharges at the stream gage. Table 3-3 also provides an estimate of peak discharge magnitudes at the two flow change locations within the study area reported in the FIS.

Table 3-3
Summary of Hydrologic Estimates at the Red Falls Stream Gage

ACE (RI)	At Red Falls, NY		Upstream Lewis Creek		Upstream West Hollow	
	Effective	Re-analyzed	Effective	Re-analyzed	Effective	Re-analyzed
50 (2)	N/A	3,660	N/A	3,010	N/A	2,400
10 (10)	8,600	11,200	8,060	8,140	6,970	5,730
4 (25)	N/A	15,300	N/A	11,100	N/A	7,780
2 (50)	14,910	18,300	13,980	13,400	12,120	9,520
1 (100)	18,130	21,300	17,010	15,800	14,770	11,400
0.2 (500)	27,040	29,700	25,410	22,400	23,130	16,300

Reviewing Table 3-3, the re-analyzed flows at the Red Falls stream gage generally increased from those reported in the FIS. At lower discharges, the difference was approximately 30 percent whereas at higher discharges, the difference was approximately 10 percent. The principal reason for this increase was the discharges estimated from the Bulletin 17C analysis were much larger than those estimated in the FIS: the estimated 1 percent ACE discharge per the Bulletin 17C analysis was 55,400 cubic feet per second (cfs), comparable to 1 percent ACE discharge of the

[1] The Annual Chance Exceedance (ACE) of a flood event can be converted to an average annual recurrence interval using the following formula: Recurrence Interval = 1 / ACE. For example, a 2-percent ACE would have an average recurrence interval of 50 years (50 = 1 / 0.02). The ACE is recent terminology that has been adopted in this report to better communicate that a given flood event has a certain percent chance of occurrence in any given year, NOT that it occurs only once in a given period of time as has sometimes been construed when using the old recurrence interval terminology. In other words, it is possible for this "50-year flood" to occur twice in one year, in back-to-back years, or not at all for a period of time much greater than 50 years. For an explanation of this concept, a "50-year flood" which has a two percent annual chance of being exceeded, would have approximately the same chance of occurrence as drawing three-of-a-kind on the first draw in a game of five-card stud poker.

much larger Schoharie Creek above its confluence with the Batavia Kill. These large discharges estimated from the Bulletin 17C analysis were due to the magnitude of the Hurricane Irene event in relation to other discharges and the relatively short stream gage record; it's expected the Bulletin 17C analysis will yield lower discharge estimates as additional data is measured and collected at the Red Falls gage. It should be noted, however, that the Bulletin 17C analysis did not identify the Hurricane Irene discharge as an outlier. Also, in the re-analyzed numbers reported in Table 3-3, the Bulletin 17C discharge was decreased after weighting with StreamStats estimates (USGS, 2018b) to compensate for the short gage record, per the procedures of Lumia et al., 2006.

Within the Ashland LFHMP study area, the re-analyzed hydrology resulted in peak discharges that were less than that estimated in the FIS. This is due to the weighting methodology that decreases the weight of the Bulletin 17C estimate with increasing distance from the stream gage, so the skewing effect of the Hurricane Irene discharge decreased for the upstream flow changes locations. In addition, the most recent series of regression equations provided in Lumia et al., 2006 yield lower discharges for the same ACE than did the previous Lumia (1991) regressions.

Given the range of results identified in Table 3-3, WEC deferred to FEMA guidance for revising hydrology to select the hydrology that will form the basis of the ensuing hydraulic analyses. For revising hydrology, FEMA guidance recommends adopting the effective hydrology unless the revised hydrology is calculated to be outside of the standard error associated with the calculation of the effective hydrology (FEMA, 2016). For this case, the standard error associated with the effective hydrology ranges from 24 to 34 percent (Lumia, 1991). At each of the flow change locations in the hydraulic model, the revised hydrology is within the standard error associated with the effective hydrology. Therefore, the effective hydrology was retained for the LFHMP. However, the revised hydrology was used to supplement the effective hydrology to quantify the 50- and 4-percent ACE events, for which estimates are not available in the FIS.

3.3.2 Hurricane Irene

One streamgage within the Batavia Kill watershed was active at the time of Hurricane Irene to measure discharge related to that event: the Batavia Kill at Red Falls near Prattsville, NY streamgage (USGS Gage 01349950). Other streamgages in the watershed (Maplecrest and Ashland) were discontinued prior to the event. Figure 3-4 provides the series of annual peak discharges recorded in the 21-year record of the Red Falls gage. As can been seen, Hurricane Irene was a notable event well in excess of previously observed storm events. In relation to the reported discharges in Table 3-3, Hurricane Irene was in excess of an event with a 0.2 percent ACE, or a 500-year recurrence interval. Although the gage record at Red Falls is short, the streamgage on Schoharie Creek dating back to 1904 also affirms how unprecedented the Hurricane Irene event was in relation to previously-observed discharges. Figure 3-5 provides the series of peak discharges recorded in the 113-year gage record at the Schoharie Creek at Prattsville gage. As can be observed, Hurricane Irene was more than twice the magnitude of previous discharges and was quite clearly an unprecedented event.

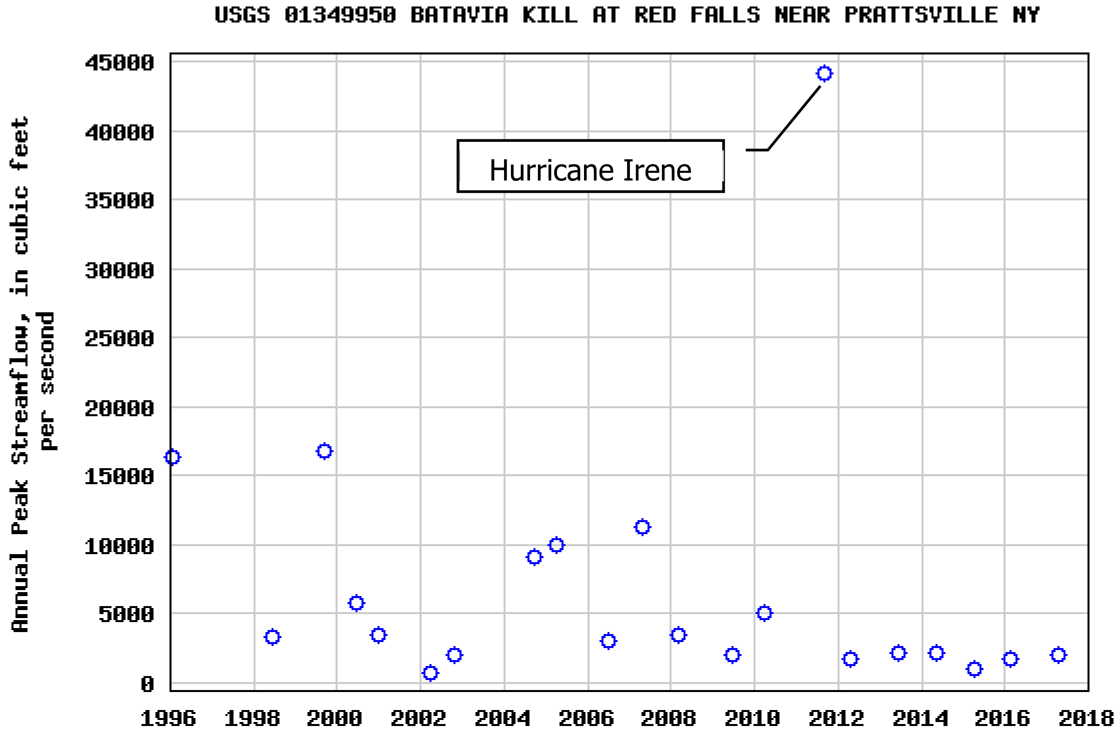

Figure 3-4. Annual Peak Discharges at Batavia Kill at Red Falls Gage (from USGS, 2018a)

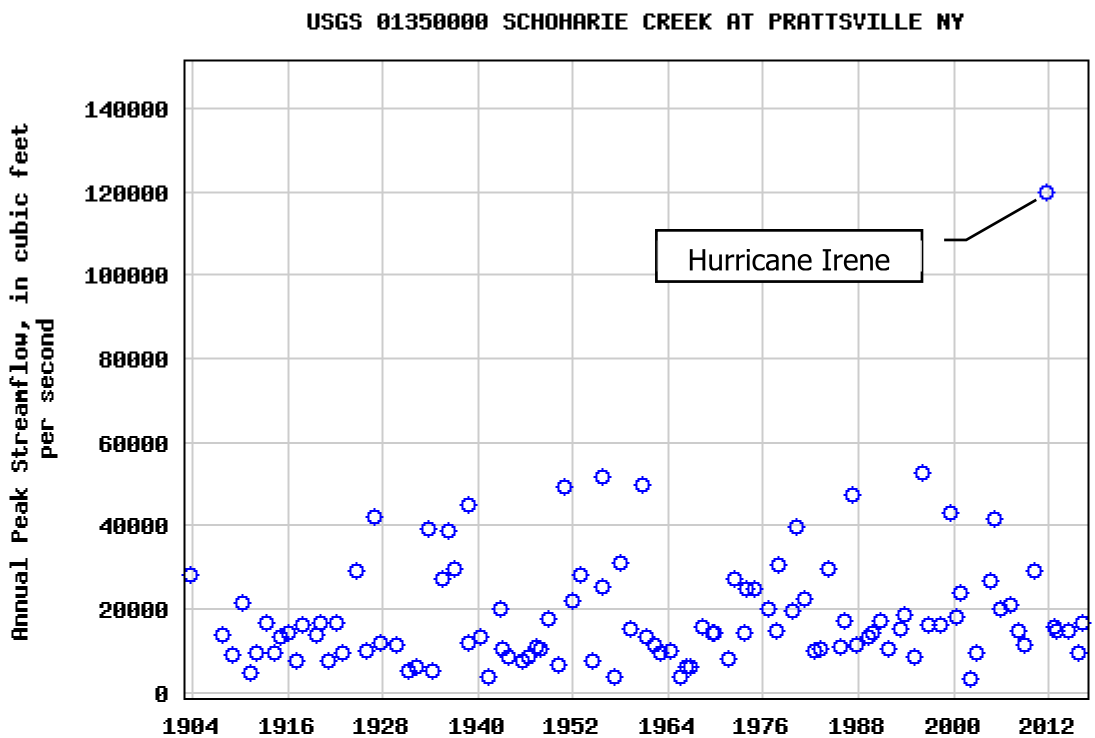

Figure 3-5. Annual Peak Discharges at Schoharie Creek at Prattsville Gage (from USGS, 2018a)

To support the validation of the hydraulic model, WEC estimated the magnitude of discharge along the Batavia Kill within the study reach during Hurricane Irene. As only one streamgage was active during the event, estimation of discharges along other portions of the Batavia Kill required extrapolation of the discharge measured at Red Falls. To do this, WEC extrapolated the measured discharge at Red Falls in three ways:

- By fitting a best-fit regression to a plot of discharge and ACE at the Red Falls gage. This regression was extrapolated to the Hurricane Irene discharge for a recurrence interval estimated for Hurricane Irene. This recurrence interval was then used to repeat the same process at the other locations of interest, this time using the recurrence interval to estimate a discharge from the extrapolated regressions.
- By using the regression exponent of the drainage-area only regression for the 0.2-percent ACE in the study area to "translate" the measured discharge to the study area as a function of drainage area.
- Same as the above, except using an exponent that was determined from a plot of recorded peak discharges versus drainage area for stream gages on the east side of the Schoharie Creek watershed. Of note, the calculated exponent was nearly identical to the one previously noted.

Each of the methods above has an inherent uncertainty. Differing rainfall depths, watershed topography, temporary debris blockages, etc., can all affect the downstream flow of water during a storm event. Recognizing this, WEC estimated the approximate discharge of the Hurricane Irene event to be approximately 36,300 to 39,100 cfs upstream of Lewis Creek and 28,900 to 34,100 cfs upstream of West Hollow.

3.4 Hydraulic Modeling (Flow Depths)

3.4.1 Duplicate Effective Model

As part of the LFHMP, development of a hydraulic model for the Batavia Kill in the Town was necessary to quantify the existing flood risk and reductions in flood risk that would be expected from potential mitigation projects. The most recent hydraulic model for the Batavia Kill is associated with the FIS for Greene County. The FIS reports this model was developed in 2004 using the US Army Corps of Engineers' (USACE) Hydraulic Engineering Center River Analysis System (HEC-RAS). WEC obtained this existing hydraulic model from the New York State Department of Environmental Conservation (DEC) Floodplain Management office to review its suitability for use in the LFHMP. This effective model, once run by WEC in HEC-RAS version 5.0.3 is referenced here forth as the "Duplicate Effective Model" and sometimes abbreviated as "DupEff". Prior to any detailed review of the model, the first step is to confirm that the Duplicate Effective Model reproduces the results from Effective Model used to develop FIRMs for Greene County. The results of this comparison are provided in Table 3-4 and confirm that the Duplicate Effective Model reproduces the water surface elevations reported for the Effective Model.

Table 3-4
FIS Lettered Sections Water Surface Elevation Comparison

River Station		FIS Letter	FIS	DupEff	Location
Miles	Feet**		WSEL (ft)	WSEL (ft)	
10.61590	56052.4	M	1468.8	1468.80	Outside Project Limits
8.59070	45359.2	L	1437.5	1437.53	Within Project Limits
6.93385	36610.9	K	1421.3	1421.35	Within Project Limits
5.98405	31595.9	J	1405.4	1405.38	Within Project Limits
5.03747	26597.9	I	1396.0	1396.02	Within Project Limits
3.64407	19240.7	H	1359.8	1359.81	Outside Project Limits

**River stations in feet, estimated from HEC-RAS river stations reported in miles

Prior to reviewing the model, it was noted that considerable changes have occurred along the study area since 2004 that would not be reflected in the model. These changes include GCSWCD's completion of several stream restoration projects which would affect flood elevations, replacement of the County Road 17 bridge, and erosion and deposition that occurred during Hurricane Irene. However, these channel changes may be insignificant during large flood events when a significant portion of flow is conveyed via the floodplain. Therefore, WEC acknowledged these changes and continued with performing a detailed review of the Duplicate Effective Model to assess its appropriateness for use in the LFHMP.

In general, roughness values, a key parameter affecting modeled flow depths, utilized in the Duplicate Effective hydraulic model, appeared to be significantly higher than typical values based on observed field conditions. In addition, roughness values varied significantly for the same surfaces between adjacent cross-sections. Across the entire model, roughness values varied from 0.025 to 0.45, which does not match those reported in the FIS report, which range from 0.025 to 0.20. It is WEC's opinion that these roughness values were generally overestimated and at a minimum, they are higher than those reported in the FIS.

Acknowledging that different modelers may develop different, but equally-viable models, for the same river, WEC sought to objectively assess the performance of the Duplicate Effective Model. To do so, WEC procured observed high water marks that could be compared to water surface elevations calculated by the Duplicate Effective Model for identical conditions. Two sources of observed high water marks were available for this study:

- Surveyed high water marks near the existing Ashland wastewater treatment plant for the October 1, 2010 event, provided by GCSWCD (2010).
- Anecdotal high water marks reported by residents and business owners along the Batavia Kill.

While the anecdotal high water marks provide useful data to validate the hydraulic model, it should be noted that the accuracy of this data is significantly less than that of the GCSWCD (2010) high water marks. Nonetheless, the observed high water marks generally made sense (increased in a fairly linear pattern in the upstream direction) in comparison to expected water surface elevations, so the 2011 high water marks were retained for comparative purposes. Figure 3-6 provides the longitudinal profile of the Batavia Kill within the study area; observed high water marks are identified by small black diamonds. The modeled 2010 event is shown in red and the modeled Hurricane Irene flow is shown in blue and green (representing the high and low, respectively, estimates of the Hurricane Irene event).

As can be seen in Figure 3-6, the Duplicate Effective Model does a fair job of re-creating the 2010 event, but the modeled water surface elevations for the Hurricane Irene event are consistently above the observed high water marks. For the Hurricane Irene event, the modeled water surface elevations are consistently 4 to 6 feet higher than those observed. While some error is expected in the 2011 dataset, attributing a consistent 4 to 6 feet of difference to human error from seven independent sources (local residents) is unlikely. As another example, modeling of the 2010 event indicated that the Greene County Highway Garage would have been flooded in 2010, but no such event occurred. While WEC notes the Duplicate Effective Model conservatively estimates flood risk for the Town, this degree of conservatism could skew the results of LFHMP by overestimating the frequency of flood damage, thereby over-estimating the cost-effectiveness of flood mitigation projects that reduce flood damage. For example, the Duplicate Effective Model would have predicted flooding of the Greene County Highway Garage approximately once every five years, thereby overestimating the long-term costs of flood damage and over-stating the cost-effectiveness of potential solutions to mitigate flooding. In an extreme case, use of the Duplicate Effective Model could yield cost-effective projects that if built could protect infrastructure that was only flooded because of how extreme Hurricane Irene was.

3.4.2 Corrected Effective Model

Due to the concerns with the Duplicate Effective Model noted in the previous section, WEC elected to update the Duplicate Effective Model to develop what is termed a Corrected Effective model, with the goal that the Corrected Effective Model will be more representative of the actual flood risk in the study area. The updates made to develop the Corrected Effective Model include those representative of physical changes in the system as well as professional judgment in the approach and parameters selected to model the hydraulics of the system. A summary of the changes to develop the Corrected Effective Model are summarized below:

- Incorporated survey information from GCSWCD representing the as-built condition of four stream restoration projects constructed in the study area since 2004;
- Incorporated the grading for the Ashland Wastewater Treatment Plant, built in 2011;
- Incorporated survey information from Greene County Department of Public Works for the as-built condition of the new County Road 17 bridge;
- Re-delineated roughness values using aerial imagery and detailed data; and
- Re-selected roughness values based on professional judgment.

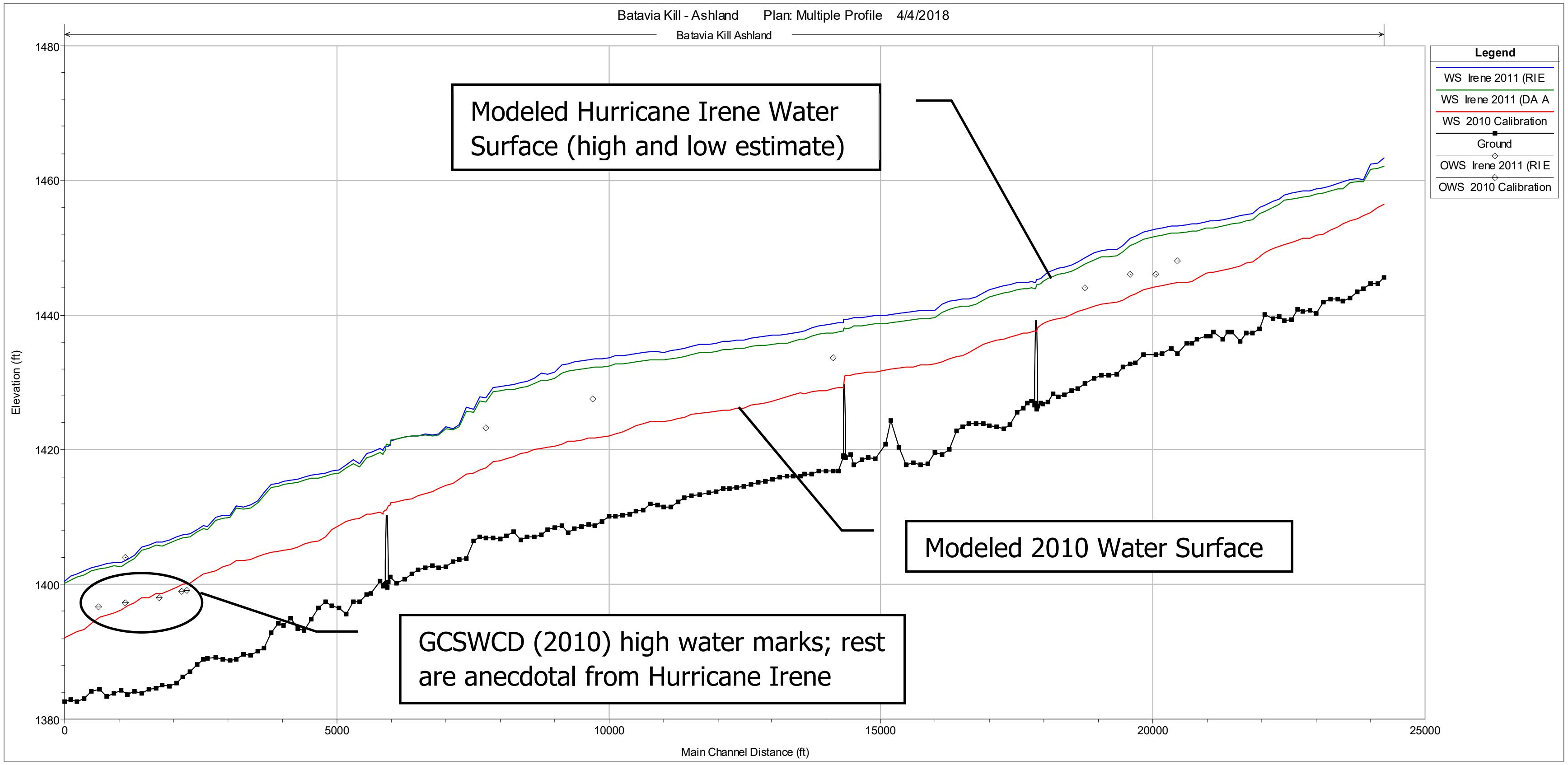

Figure 3-6. Comparison of Duplicate Effective Model to Observed High Water Marks

WEC also notes that these changes are not intended to encompass all physical changes nor modeling improvements that should be completed to fully update the 2004 model, but it is WEC's opinion that these changes increase the accuracy of the model to a point that its results can be used to inform reliable decisions related to potential flood mitigation projects. However, based on these results, WEC recommends that the Town consider requesting that FEMA update the hydraulic model of the Batavia Kill and re-map the floodplain of the Batavia Kill. If such a request is made, the study is added to a state-wide list of requested flood hazard mapping studies maintained by the DEC. Funding for re-mapping is then allocated by FEMA based on need. As such, the timing of a re-mapping study is contingent on the need to re-study the Batavia Kill in relation to other submitted re-study requests. To strengthen the need for the re-study, the Town may consider submitting the request with the adjacent communities of Prattsville and Windham which may also benefit from improved hydraulic modeling. To further expedite the re-study, the Town and adjacent communities also have the option to self-fund the re-study. If progressed, the updated model would improve the accuracy of the jurisdictional floodplain throughout the Town with the expectation that the flood depths would decrease. If so, decreased flood depths could lead to decreased flood insurance rates for private property owners and potentially remove some structures entirely from the jurisdictional floodplain.

To validate the Corrected Effective Model, WEC again compared observed water surface elevations to modeled water surface elevations of that particular event. The results of this comparison are provided in Figure 3-7. In general, the Corrected Effective Model is a significant improvement from the Duplicate Effective Model. For the 2010 event in which there are more accurate observed high water marks, the model generally re-produced these water surface elevations within a few inches. For high water marks observed during Hurricane Irene, the model generally reproduced water surface elevations within a foot. Notable exceptions include an observed high water mark near the Ashland wastewater treatment plant (WWTP). However, there was significant erosion and channel widening downstream of this that could have increased the conveyance capacity of the Batavia Kill during the 2011 event, but this is not represented in the model since the area has since been re-graded.

Considering the above, WEC considers the developed Corrected Effective Model to the best available information for the LFHMP and adopted it for use in the remainder of the LFHMP as the baseline condition against which potential mitigation alternatives will be developed upon and compared to.

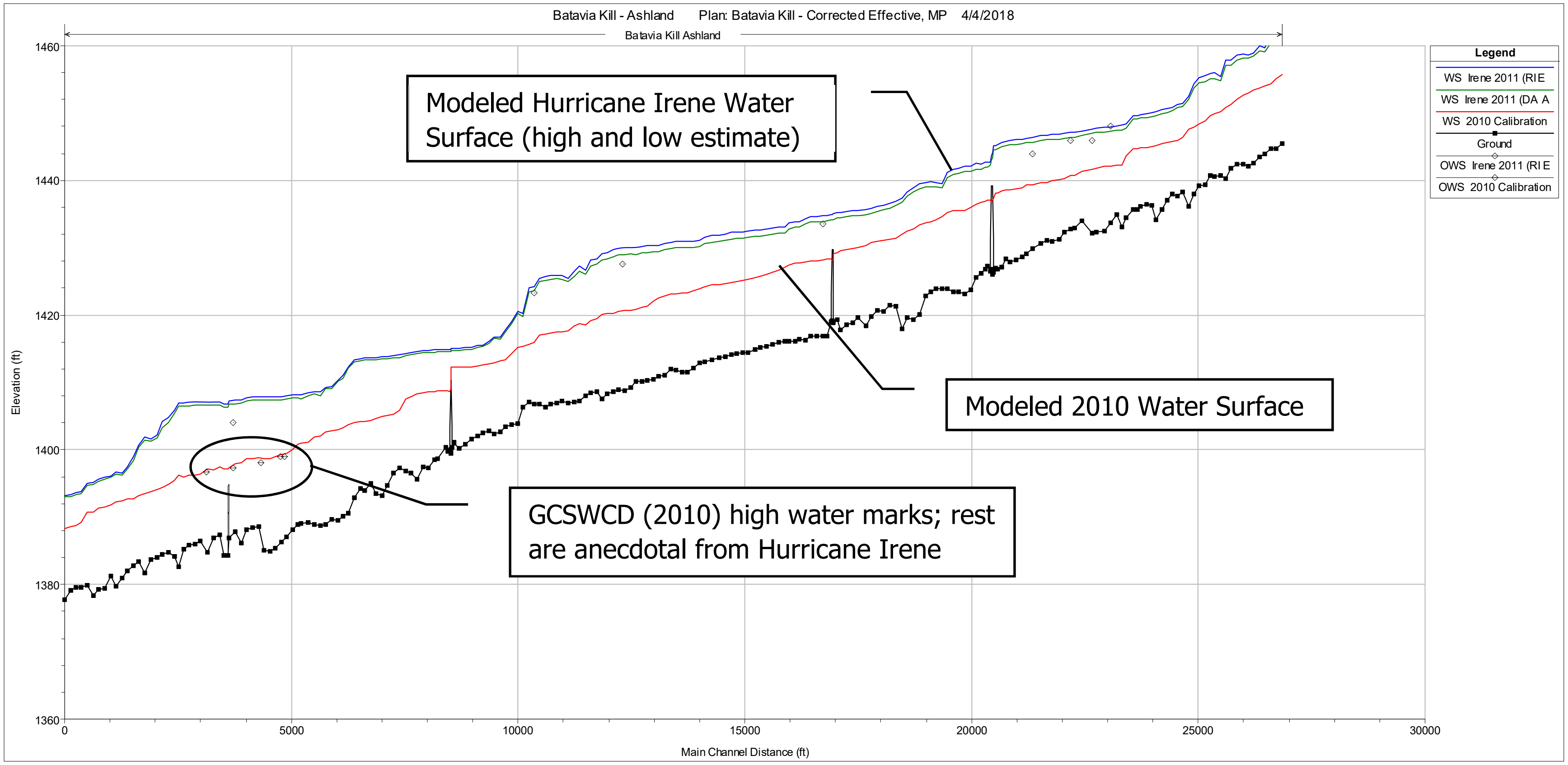

Figure 3-7. Comparison of Corrected Effective Model to Observed High Water Marks

3.5 Flood Risk Mapping

3.5.1 Flood Inundation Limits

Effective flood inundation extents corresponding to the Duplicate Effective Model are identified on the Flood Insurance Rate Maps (FIRMs) issued by FEMA for the Town of Ashland. The effective FIRMs for the Town have been consolidated as Exhibit 1 in Appendix A for reference.

Revised flood inundation maps using the Corrected Effective Model were developed by using HEC-RAS software to delineate the inundation extents by comparing water surface elevations to the elevation of existing ground. The elevation of existing ground was derived from 2009 2-meter lidar (NYSGPO and NYCDEP, 2009) available from the New York GIS Clearinghouse. The revised flood inundation limits for the 10-, 1-, and 0.2-percent annual chance exceedance events are provided as Exhibit 2A through Exhibit 2F in Appendix A. While the Corrected Effective Model would need additional modifications to be submitted for updating of the FIRMs, the 1- and 0.2-percent annual chance exceedance events would most closely correspond to Zone AE and Zone X Special Flood Hazards Area identified on the effective Flood Insurance Rate Maps for the Town. For comparative purposes, the existing Special Flood Hazard Areas have also been provided on Exhibit 2.

3.5.2 Flood-Prone Properties

Flood-prone properties incorporated into the Benefit-Cost Analyses described in later sections were identified by WEC as primary structures within the limits of the Special Flood Hazard Area defined by FEMA and provided in Exhibit 1 of Appendix A. Outbuildings including garages and sheds were not included in the development of the flood-prone property database. As part of its field survey, WEC also identified flood-prone structures as primary structures adjacent to the 0.2-percent ACE that have basements or low-lying first floors that may be inundated by high groundwater caused by flooding. Following community concern regarding the number of identified flood-prone properties, WEC refined the identification of flood-prone properties by then removing those properties where the calculated annualized flood damages over a 100-year period were less than $1,000 (see Section 4 for description of this calculation). The resulting flood-prone properties are identified on Exhibit 3A through Exhibit 3F included in Appendix A.

It should be noted that these flood-prone properties were conservatively identified to not underestimate the flood mitigation benefits of potential alternatives; many identified properties were calculated to have low risk of flooding. Those properties identified as flood-prone are solely for this purpose and none of this information on its own will be used to impose additional flood insurance requirements or other regulations on identified properties.

3.5.3 Flood Hazards

As part of the LFHMP, WEC worked with the FAC and local community to identify flood hazards within the study area. The consolidated list of identified flood hazards is provided in Exhibit 3a to Exhibit 3F included in Appendix A. These flood hazards include both those flood hazards and areas of concern identified by the FAC in meetings as well as flood hazards identified by the local community during the December 13, 2017 public meeting. In addition to those flood hazards identified by the FAC, WEC also identified additional flood hazards as part of its site visit and included these flood hazards in those mapped in Exhibit 3 in Appendix A.

In addition to the flood hazards defined in Section 1.2, water quality hazards within the study area were also identified. For the LFHMP, water quality hazards are defined to be standalone sources of potential pollutants that are at risk of being washed downstream during a flood event. These water quality hazards may be natural, such as silts and clays that could be eroded during a flood, or artificial, such as used oil in an automotive garage. Although not specifically identified as such, it should be noted that every flood-prone property is also a potential water quality hazard as flooding of a private property could cause contamination of downstream water if household chemicals, debris, fuel tanks, or other sources of pollutants are damaged or otherwise washed downstream.

4.0 Mitigation Alternatives Analysis

4.1 General Approach

4.1.1 Alternatives Development

Following the identification of potential flood hazards and corrected flood risk mapping using the Corrected Effective Model, the next step in the LFHMP process is to develop potential projects to mitigate the identified flood hazards and provide ancillary benefits. A brief description of the types of flood mitigation projects that are considered during the LFHMP process include the following:

1. **Flood Damage Prevention and Planning** – Actions that lower flood elevations or prevent future losses (such as channel and floodplain modifications, floodplain reclamation, and adoption or amendment of land use regulations, building codes, or flood damage prevention regulations).
2. **Structural Projects** – Action that use or modify structures to mitigate a hazard (such as replacement or retrofit of bridges and culverts, protection of critical community facilities).
3. **Natural Resource Protection** – Actions that minimize hazard loss and preserve or restore the function of natural systems (such as soil stabilization measures, bank protection and/or stabilization, landslide stabilization, attenuation of peak discharges through detention and/or storage, and debris management).
4. **Property Protection** – Actions that reduce potential damage to buildings, infrastructure, and other kinds of physical property (including property acquisition/relocation, elevation of buildings, or flood-proofing of buildings).
5. **Emergency Services** – Action that protect people and property during and immediately following a flood.
6. **Community Pollution Prevention** – Actions at the community-scale that reduce pollution during a flood event (such as securing oil and propane tanks).
7. **Public Education and Information** – Education efforts centered on the benefits of general best management practices to code enforcement officers, realtors, contractors, municipal officials, and property owners about how to protect themselves and the community from flood disasters and associated losses.

Potential mitigation projects were developed based on goals, objectives, general areas of concern, and other input from the FAC, local community, Town Board, and municipal entities. The development of specific mitigation projects was further guided by technical evaluations including use of the Corrected Effective Model to identify locations where there is greater potential to reduce base flood elevations and economic analyses of annualized flood damages to identify structures that are most at-risk (and therefore may benefit the most from flood mitigation projects). Through this process, the potential flood mitigation alternatives summarized in Table 4-1 were developed. For convenience, Table 4-1 also summarizes whether hydraulic analyses or cost-benefit analyses were performed for each of these alternatives. Detailed discussion of each of these alternatives is provided in the following sub-sections.

Table 4-1
List of Preliminary Flood Mitigation Alternatives and Analyses Performed

Alternative ID	Alternative Description	Hydraulic Analysis Performed?	Benefit-Cost Analysis Performed?
1	Modification of WWTP discharge pipe	Yes	No
2	Gravel pit bridge improvement	Yes	No
3	Maier Farm bridge improvement	Yes	No
4	County Road 17 floodplain relief culverts	Yes	No
5	County Road 17 bridge widening and adjacent floodplain bench	Yes	Yes
6	Floodplain reclamation above WWTP	Yes	No
7	Floodplain bench near Ashland Town Park	Yes	No
8	Floodplain reclamation below Carrington Road	No	No
9	Relocation of Greene County Highway Garage	No *	Yes
10	Protective levee around Greene County Highway Garage and Winco Park	Yes	Yes
11	State Route 23 profile raise	No	No
12	Structure elevations	No *	Yes
13	Structure acquisitions	No *	Yes
14	Fuel Tank Anchoring	No	No **

* Benefit-cost analyses for these alternatives were dependent only on existing conditions
** Benefit-cost analyses have been performed by others separately from the LFHMP

4.1.2 Flood Risk Reduction

For those alternatives identified in Table 4-1 for which hydraulic modeling was performed, separate hydraulic models for the proposed mitigation alternative were developed. These separate hydraulic models were developed by copying the Corrected Effective Model and modifying its parameters to reflect the geometry and appropriate hydraulic characteristics of the proposed mitigation alternative. This method provided a direct quantification of the potential reduction in flood stage and flood extent that may be achieved by a proposed mitigation alternative. Flood inundation limits for the proposed mitigations alternatives were developed using the same procedure as for existing conditions detailed in Section 3.4.1.

For brevity, only the results for the base flood, which is the 1-percent ACE ("100-year flood") and the event to which flood insurance rates are based from, are presented in the exhibits illustrating the project alternatives.

4.1.3 Benefit-Cost Analyses

A key component of the LFHMP is the calculation of Benefit-Cost Ratios (BCRs) for proposed mitigation alternatives. BCRs are used to quantify the cost-effectiveness of a proposed mitigation project using the following equation:

$$BCR = \frac{Project\ Benefits\ (in\ dollars)}{Project\ Costs\ (in\ dollars)}$$

The following bullets summarize the basic interpretation of calculated BCRs:

- For a BCR less than 1.0, project costs exceed the project benefits. In other words, for every dollar spent on the project, the expected benefit would be *less* than one dollar.
- When a project costs are exactly equal to its anticipated benefits, the project would have a BCR of 1.0. This is the minimum requirement for a project to be considered cost-effective for receipt of some grant funding, including FEMA grants.
- For a BCR less than 1.0, project benefits exceed the project cost. In other words, for every dollar spent on the project, the expected benefit would be *more* than one dollar.

While the BCR equation is relatively simple, the quantification of project benefits and projects cost is more complex. As such, BCR ratios were only developed for those flood mitigation alternatives that had the greatest flood risk reduction and whose benefits were reasonably anticipated to equal or exceed the project costs. Unless noted otherwise in the following subsections or on the detailed cost estimates provided in Appendix B, project costs were developed by WEC using the following assumptions:

- Cost estimates were developed to a level commensurate to a Class 5 estimate as defined by AACE International; a Class 5 estimate is appropriate for concept screening, such as this LFHMP, where exact project details are not yet defined;
- "Hard" costs, or those for construction, were developed from simplified unit costs (e.g., dollar per square foot) or scaling of comparable stream restoration or flood recovery projects in upstate New York either completed by WEC and/or recently funded by the Governor's Office of Storm Recovery or the Catskill Watershed Corporation;
- Where proposed projects would entail permanent property impacts, acquisition or easement costs of $7,500/acre were included. These costs were developed based on May 2018 realty listings for undeveloped property along the Batavia Kill in Ashland;
- Engineering costs of 10 to 20 percent of the construction subtotal were included; the higher end of this range was generally used for alternatives that did not include steel, concrete, or other materials that are generally more expensive than earthwork;
- Permitting costs were estimated based on the anticipated need for environmental assessments and permits, building permits, and floodplain development permits; and,
- Owner administrative costs of 10 percent of all other items were included for procurement, project management, administration, and public outreach of the project.

WEC used FEMA's Benefit-Cost Analysis Toolkit, v5.3.0 (FEMA, 2009) to estimate the anticipated benefits of the project and calculate a BCR by comparing these benefits to WEC's estimated project cost. FEMA's Benefit-Cost Analysis Toolkit estimates project benefits by estimating annualized flood damages for each structure under existing conditions and comparing those costs to estimated annualized flood damages under proposed conditions; the difference between these costs is the anticipated benefit. Additional benefits including avoided displacement costs, avoided loss of function (e.g., unpaid wages due to flood closure), and anticipated environmental and social benefits can also be analyzed and included. The following bullets summarize WEC's assumptions and decisions used to implement FEMA Benefit-Cost Analysis Toolkit:

- Structures were classified into classes (residential or commercial), structure types, and further sub-divided based on the presence of a basement based on WEC's field observations of the structures from public roadways;
- First floor elevations were determined by adding the field-observed difference between low adjacent ground and the first finished floor elevation to the lowest elevation of existing ground adjacent to the structure as determined from lidar data. For potential basements, the potential basement was classified as a finished floor if it had two or more means of egress (windows or doors);
- Square footage of structures was determined from geospatial analysis of aerial imagery; the square footage was doubled for structures field-observed to be two stories;
- Flood-damage curves were the default FEMA curve included in the Benefit-Cost Analysis Toolkit for the class and type of structure;
- Displacement costs were included assuming US General Services Administration per diem rates, 3 people per household (the average occupancy of houses in Ashland, rounded up to the nearest integer), and standard costs provided in FEMA (2009);
- Building Replacement Values were calculated as the greater of the assessed value, adjusted for the 2017 Ashland assessment equalization rate of 74 percent, and the following:
    - Single-family residences and wood-framed commercial structures: $81/square foot (locally-adjusted from Craftsman Book Company, 2017)
    - Manufactured homes: $41/square foot (US Department of Housing and Urban Development, 2015)
    - Steel-framed commercial structures: $150/square foot (determined from communications with local engineers engaged in this type of work); and,
- FEMA standard values provided in FEMA (2009) were used for project useful life, discount rate (seven percent), and building contents value.

Unless noted otherwise in the following sub-sections, avoided loss of function, environmental benefits, and social benefits of the projects were not included in the project benefits.

4.1.4 Feasibility Assessment Criteria

To evaluate the feasibility of proposed mitigation alternatives, WEC modified the scoring matrix developed for the feasibility assessment of potential flood mitigation projects for the LFHMP completed for the Village of Delhi, NY (WEC, 2017); this scoring matrix was developed with the Village of Delhi FAC which included Delaware County Soil and Water Conservation District and DEP. The scoring matrix and qualitative descriptions of scores used to score and rank the feasibility of the potential flood mitigation alternatives based on the achievement of project goals, anticipated impacts, regulatory requirements, economic impact, and other metrics is summarized in Table 4-2.

Table 4-2
Feasibility Metrics for Mitigation Solutions

Priority Metric	Example of "5" score	Example of "3" score	Example of "1" score
Water Quality Protection	Greater than five chemical or natural occurring water pollution sources mitigated	Two chemical or natural occurring water pollution sources mitigated	Zero chemical or natural occurring water pollution sources mitigated
Downstream and Upstream Benefits /Impacts	Increase in flood storage; decrease of BFE more than 1 foot for two or more structures; no negative sediment transport implications anticipated.	Negligible change in flood storage; change in BFEs of less than 1 foot at one or more structures; minor sediment erosion or deposition anticipated.	Significant loss of flood storage; increase in BFEs greater than 1 foot at one or more structures; significant sediment erosion or deposition anticipated.
Public Benefit	Protection of critical facility; additional public good or service	No net change to public goods or services	Elimination of public good or service
Community Cohesion Preservation	Increases connectivity of community; fosters development of economic or cultural center	Minimal disturbance to existing community layout (no private residences needing relocation)	Greater than three private residences need relocation, or greater than one anchor business needing relocation
Ease of Obtaining Permits for Proposed Solution	Project generally benefits environment; few challenges anticipated to obtain permits	Project generally has negligible impact to environment; some challenges anticipated to obtain permits	Project generally has some negative impact to environment; some challenges anticipated to obtain permits
Economic Impact	Significant benefit to the local economy	Negligible impact to the local economy	Moderate to high negative impact to local economy
Ease of Obtaining Funding	Good confidence that two or more sources of funding could be used to implement solution	Moderate to good confidence that one source of funding could be used to implement solution	Low confidence that funding could be obtained to implement solution
Ease to Acquire Easements	No easement necessary	Two or three parcels of land will require an easement	Three of more parcels of land will require an easement
Technical Complexity	No specialized engineering; no specialized construction; minor conflicts with built infrastructure	Some specialized engineering; limited specialized construction; few conflicts with built infrastructure	Specialized engineering or construction required; numerous conflicts with built infrastructure
Administrative Effort	Low level of effort required by Town	Moderate level of effort required by Town	High level of effort required by Town

4.2 Alternative 1 – Modification of WWTP Discharge Pipe

Table 4-3 Summary Metrics for Alternative 1	
Priority Metric	Score
Water Quality Protection	N/C
Downstream and Upstream Benefits /Impacts	N/C
Public Benefit	N/C
Community Cohesion Preservation	N/C
Ease of Obtaining Permits for Proposed Solution	N/C
Economic Impact	N/C
Ease of Obtaining Funding	N/C
Ease to Acquire Easements	N/C
Technical Complexity	N/C
Administrative Effort	N/C
Total	**N/C**
Total Benefits	N/C
Total Costs	N/C
Benefit-Cost Ratio (BCR)	**N/C**

During the public outreach process, the wastewater treatment plant discharge pipe at the Ashland WWTP was identified by community members as a potential riverine flooding hazard. There was a general concern that the backfill atop the pipe, which is two to three feet higher than adjacent ground, may act as a small berm that can exacerbate upstream flooding. Therefore, WEC developed a flood mitigation alternative in which this backfill is removed. Exhibit 4a in Appendix A provides a conceptual rendering of this proposed alternative as well as the modeled reduction in flood inundation extents at the base flood elevation.

Hydraulic Analysis: To quantify the reduction in flood risk, WEC developed a proposed conditions hydraulic model in which the backfill atop the proposed WWTP discharge pipe was removed. Table 4-4 summarizes the modeled reduction in water surface elevations from existing conditions to the proposed without-pipe conditions. In general, the hydraulic impact of removing this obstruction was minimal: upstream water surface elevations decreased less than 1 inch and only benefitted the area immediately around the WWTP for a distance of 800 feet upstream; there was no modeled decrease in water surface elevations at upstream residences.

Benefit-Cost Analysis: As the hydraulic benefits resulting from this alternative were unlikely to result in a flood benefit, the benefit-cost ratio of this alternative was assumed to be well below 1.0 and no benefit-cost analysis was performed for this alternative. In addition, elimination of this backfill would likely necessitate re-alignment of the pipe through DEP-protected lands to maintain adequate gravity drainage; these lands are currently protected from development such that easements would be difficult to procure.

Feasibility Assessment: Given the above considerations, no feasibility assessment was performed for this alternative.

Table 4-4
Summary of Alternative 1 Flood Risk Reduction

Location	Model XS	Modeled Reduction in Water Surface Elevation (ft)			
		50pct ACE	10pct ACE	1pct ACE	0.2pct ACE
At Pipe	5.70772	-0.04	-0.06	-0.05	-0.04
@ Upstream WWTP	5.75695	-0.02	-0.03	-0.01	-0.01
900 ft u/s WWTP	5.97185	0.00	0.00	0.00	0.00

4.3 Alternative 2 – Gravel Pit Bridge Improvement

During the public outreach process, the "gravel pit bridge" to the new Ashland Town Park was identified by community members as a potential riverine flooding hazard. There was a general concern that the bridge is under-sized and may exacerbate upstream flooding.

Table 4-5
Summary Metrics for Alternative 2

Priority Metric	Score
Water Quality Protection	N/C
Downstream and Upstream Benefits /Impacts	N/C
Public Benefit	N/C
Community Cohesion Preservation	N/C
Ease of Obtaining Permits for Proposed Solution	N/C
Economic Impact	N/C
Ease of Obtaining Funding	N/C
Ease to Acquire Easements	N/C
Technical Complexity	N/C
Administrative Effort	N/C
Total	**N/C**
Total Benefits	N/C
Total Costs	N/C
Benefit-Cost Ratio (BCR)	**N/C**

Hydraulic Analysis: To assess the degree to which this bridge may increase upstream flooding, WEC developed a proposed conditions hydraulic model in which the bridge was entirely removed. Complete removal of the bridge is not a feasible alternative, but modeling this alternative yields a "best-case" scenario of flood risk reduction to determine whether additional analysis is warranted. Table 4-6 summarizes the modeled reduction in water surface elevations if the bridge were entirely removed. Based on the modeling results, if the bridge were removed entirely there would be an approximate 14-inch decrease in water surface elevation at the 50 percent ACE which, on average, occurs every-other-year. However, at higher discharges, complete removal of the bridge would only decrease upstream water surface elevations less than three inches immediately upstream of the bridge. As shown in Exhibit 4b in Appendix A, this reduction in water surface elevations at higher discharges quickly dissipates: by approximately Sutton Hollow Road, the benefits at higher discharges such as the base flood (1-percent ACE) are negligible. The cause of this is presumed to be the relatively low floodplain on the south side of the Batavia Kill which is activated at approximately the 50 percent ACE and allows significant conveyance of higher discharges. In other words, the bridge is overtopped at high discharges and is less of a relative obstruction due to the large floodplain.

Benefit-Cost Analysis: As there are no flood-prone structures in this area, and no structures have been reported to flood on a near-annual basis, the BCR of this alternative was assumed to be significantly less than 1.0 and no cost-benefit analysis was performed for this alternative.

Feasibility Assessment: Given the above considerations, no feasibility assessment was performed for this alternative.

Table 4-6
Summary of Alternative 2 Flood Risk Reduction

Location	Model XS	Modeled Reduction in Water Surface Elevation (ft)			
		50pct ACE	10pct ACE	1pct ACE	0.2pct ACE
At bridge	6.61309	-0.43	-0.30	-0.21	-0.11
Upstream bridge	6.62274	-1.17	-0.20	-0.18	-0.11
Near W Settlement Rd	6.71953	-0.19	0.00	+0.02	-0.02
Near post office	6.81466	-0.04	0.00	0.00	0.00
Near Sutton Hollow	6.97945	0.00	0.00	0.00	0.00

4.4 Alternative 3 – Maier Farm Bridge Improvement

During the public outreach process, the Maier Farm Bridge was identified by community members as a potential riverine flooding hazard. There was a general concern that the bridge crossing is under-sized and may exacerbate upstream flooding.

Table 4-7
Summary Metrics for Alternative 3

Priority Metric	Score
Water Quality Protection	N/C
Downstream and Upstream Benefits /Impacts	N/C
Public Benefit	N/C
Community Cohesion Preservation	N/C
Ease of Obtaining Permits for Proposed Solution	N/C
Economic Impact	N/C
Ease of Obtaining Funding	N/C
Ease to Acquire Easements	N/C
Technical Complexity	N/C
Administrative Effort	N/C
Total	**N/C**
Total Benefits	N/C
Total Costs	N/C
Benefit-Cost Ratio (BCR)	**N/C**

Hydraulic Analysis: To assess the degree to which this bridge may increase upstream flooding, WEC developed a proposed conditions hydraulic model in which the bridge was entirely removed. While complete removal of the bridge may not be a feasible alternative to the property owner, modeling this alternative yields a "best-case" scenario of flood risk reduction to determine whether additional analysis is warranted. Table 4-8 summarizes the modeled reduction in water surface elevations if the bridge were entirely removed. Based on the modeling results, if the bridge were removed entirely there would be an approximate 13-inch decrease in water surface elevation at the 50 percent ACE which, on average, occurs every-other-year. However, at higher discharges, complete removal of the bridge would only decrease upstream water surface elevations less than one-inch immediately upstream of the bridge. As shown in Exhibit 4c in Appendix A, this reduction in flood inundation extents quickly dissipates and there would be no measurable decrease in flood risk at upstream residences.

Benefit-Cost Analysis: As there are no flood-prone structures that would benefit from this alternative, and the only benefits of the project would accrue to the owner of the bridge itself, the BCR of this alternative was assumed to be significantly less than 1.0 and no cost-benefit analysis was performed for this alternative.

Feasibility Assessment: Given the above considerations, no feasibility assessment was performed for this alternative.

Table 4-8
Summary of Alternative 3 Flood Risk Reduction

Location	Model XS	Modeled Reduction in Water Surface Elevation (ft)			
		50pct ACE	10pct ACE	1pct ACE	0.2pct ACE
At bridge	8.2062	-1.10	-0.74	-0.07	-0.05
700 feet u/s of bridge	8.34433	-0.24	-0.13	-0.02	-0.03
Near State Route 23	8.5406	-0.04	-0.01	0.00	0.00
Downstream CR 17	8.75508	0.00	0.00	0.00	0.00

4.5 Alternative 4 – County Road 17 Bridge Floodplain Relief Culverts

During the technical review of the Corrected Effective Model, the County Road 17 bridge was identified as a potential riverine flooding hazard due to modeled increases in upstream flood elevations on the order of approximately two to three feet as illustrated in Figure 4-1 which provides a theoretical comparison between existing conditions and "natural conditions" without the CR 17 bridge. Upon detailed review of the Corrected Effective Model, WEC's opinion is the north approach roadway to the bridge is the cause of the modeled increase, not the bridge itself: the roadway approach, which is a few feet above adjacent ground, prevents most flow across the floodplain and diverts this flow through the bridge opening. This conclusion may also explain the erosion of the north bridge approach during Hurricane Irene: as flows backed up behind and eventually overtopped the road approaches, the overtopping flow accelerated down the downstream-slope of the bridge and caused loss of the road prism.

Table 4-9
Summary Metrics for Alternative 4

Priority Metric	Score
Water Quality Protection	1
Downstream and Upstream Benefits /Impacts	4
Public Benefit	4
Community Cohesion Preservation	3
Ease of Obtaining Permits for Proposed Solution	5
Economic Impact	3
Ease of Obtaining Funding	2
Ease to Acquire Easements	4
Technical Complexity	5
Administrative Effort	3
Total	**34**
Total Benefits: $109,000	
Total Costs: $381,000 (Range: $191,000 to $762,000)	
Benefit-Cost Ratio (BCR)	0.29

To mitigate this backwater effect, WEC developed a flood mitigation alternative in which a floodplain relief culvert is installed beneath the north abutment. This additional culvert would increase the flow area beneath the bridge at flood flows, improve floodplain connectivity, and decrease scour potential at the bridge. WEC proposes a precast concrete culvert as these precast elements are less expensive in comparison to custom-designed structures; they can generally be constructed quickly and decrease construction time and traffic delays. Such a culvert could also be installed without working within the river, thus avoiding the need for in-water environmental permits that generally require a more thorough regulatory review. A depiction of this floodplain relief culvert is provided in Figure 4-2; Exhibit 4d in Appendix A provides a conceptual rendering of this proposed alternative as well as the modeled reduction in flood inundation extents at the base flood elevation.

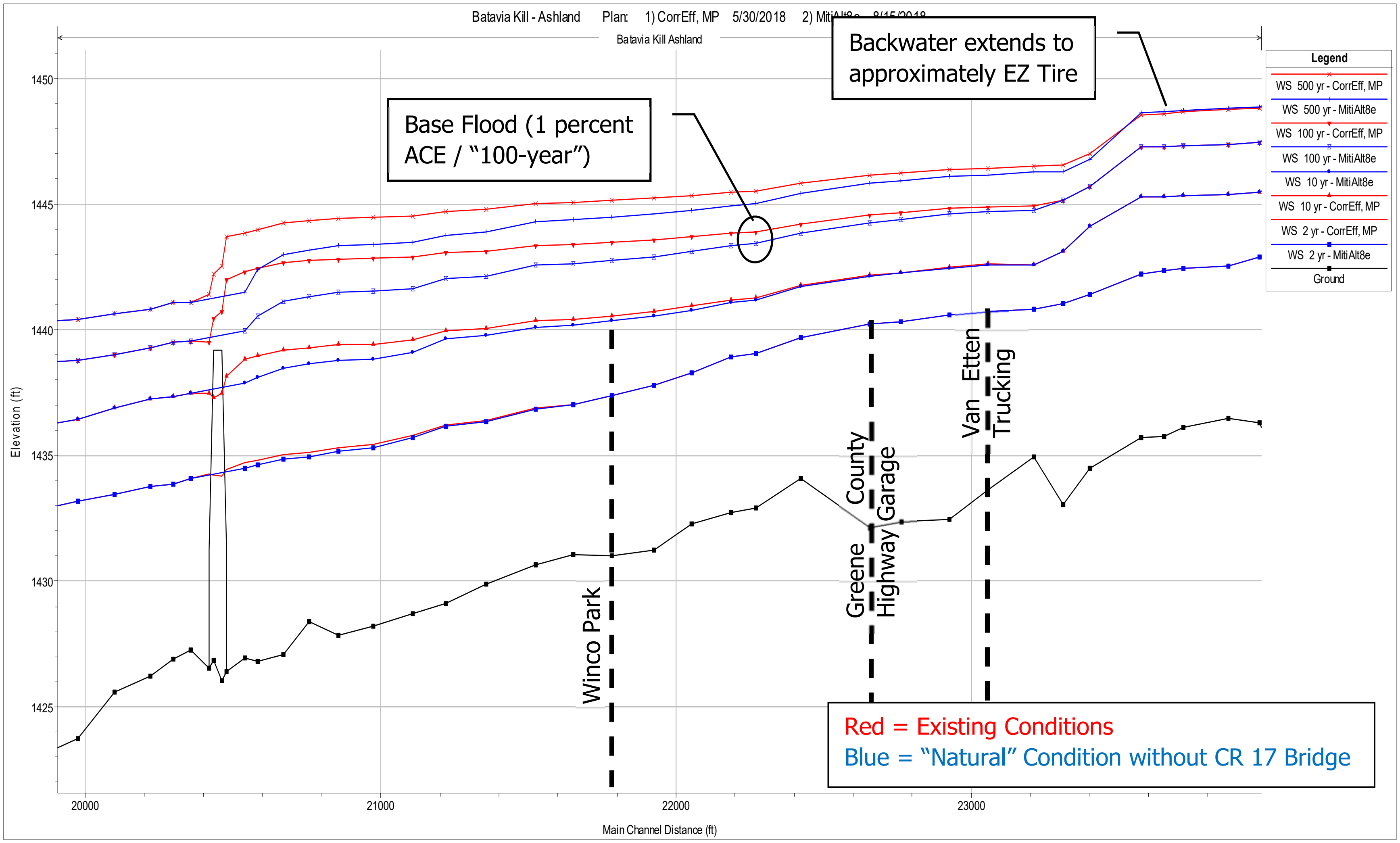

Figure 4-1: Comparison of Corrected Effective Model at County Road 17 to Theoretical "Natural Condition" Model without Bridge

Figure 4-2: Example Precast Culvert (over a stream, not a floodplain)
Source: Binghamton Precast & Supply Corp

Hydraulic Analysis: To model the flood risk reduction resulting from this flood mitigation alternative, WEC developed a proposed conditions hydraulic model in which a 20-foot concrete box culvert was added beneath the northern abutment. In addition, model cross-sections near the bridge were modified to allow for a small floodplain bench to provide connectivity to the proposed culvert. Table 4-10 summarizes the modeled reduction in water surface elevations for this alternative and Figure 4-3 provides a depiction of this floodplain relief culvert in the hydraulic model for this alternative. In general, a reduction of two to four inches in the water surface elevations of more infrequent floods would be expected at Winco Park, the Greene County Highway Garage, and Van Etten Trucking.

Table 4-10
Summary of Alternative 4 Flood Risk Reduction

Location	Model XS	Modeled Reduction in Water Surface Elevation (ft)			
		50pct ACE	10pct ACE	1pct ACE	0.2pct ACE
At County Road 17	8.87412	+0.02	+0.06	-0.67	-0.42
Country Suites	9.04031	0.00	-0.15	-0.35	-0.27
Winco Park	9.12127	0.00	-0.10	-0.32	-0.22
Greene Cnty Garage	9.24249	0.00	-0.03	-0.17	-0.14
Van Etten Trucking	9.36244	0.00	-0.01	-0.10	-0.09
Near EZ Tire	9.55176	0.00	0.00	0.00	0.00

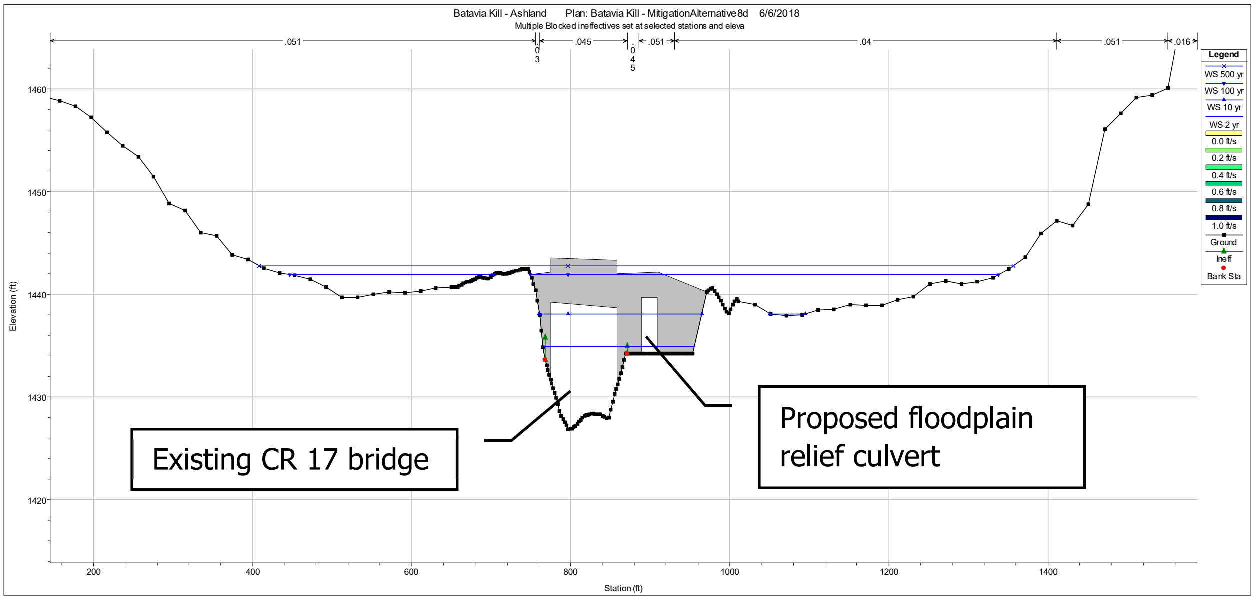

Figure 4-3: Representation of Alternative 4 in Hydraulic Model

Benefit-Cost Analysis: Given the potential that this alternative would have benefits more than its costs, WEC performed a Benefit-Cost Analysis for this alternative. No special adjustments to the assumptions summarized in Section 4.1.3 were made for this alternative. For the cost estimate, WEC used the DOT's *Preliminary Cost Estimate Worksheet (New and Replacement Bridges)* to develop a cost estimate for the proposed culvert itself (DOT, 2018). Calculated project costs and benefits are reported in Table 4-9; a detailed cost estimate is provided as Exhibit 1 of Appendix B. The calculated BCR for this alternative is 0.29, which is less than 1.0 and therefore an ineffective use of public dollars *solely* for flood risk reduction benefits at this time. However, the benefits of improving floodplain connectivity, including reduced scour potential at the bridge, improved riparian condition and shading, and reduced risk of upstream deposition are not included in these calculations.

Feasibility Assessment: Although the calculated BCR for this alternative is not currently favorable, more detailed study of this alternative or more efficient construction methods may improve the calculated cost-effectiveness of this alternative. Therefore, a feasibility assessment has been completed to quantify other metrics and the feasibility of implementing the project. WEC's opinion of feasibility metrics for this alternative are provided in Table 4-9.

Additional Studies: Prior to advancing to the design of a bridge improvement, WEC recommends a detailed feasibility study prior to beginning design of the proposed improvement. This feasibility assessment should include an updated survey of the bridge, its approach, and adjacent channel and floodplain grades, an updated hydraulic analysis using this new survey information to confirm the above analyses and address data gaps identified in Section 2.4, and a more advanced cost estimate adapted that better reflects the unique characteristics of this project site.

4.6 Alternative 5 – County Road 17 Bridge Widening

At the request of the FAC, WEC developed a second alternative for the improvement of the County Road 17 bridge. This alternative included doubling the width of the County Road 17 bridge and construction of a floodplain bench upstream and downstream of the bridge to increase the floodplain conveyance through and near the bridge. The goal of this alternative would be to increase the benefits associated with Alternative 4 even further. Also, the intent of this alternative is not to recommend replacement of the recently-replaced County Road 17 bridge, but rather to provide the rationale for funding a widened bridge span for flood risk reduction purposes the next time the bridge needs to be replaced.

Table 4-11
Summary Metrics for Alternative 5

Priority Metric	Score
Water Quality Protection	1
Downstream and Upstream Benefits /Impacts	5
Public Benefit	4
Community Cohesion Preservation	3
Ease of Obtaining Permits for Proposed Solution	3
Economic Impact	3
Ease of Obtaining Funding	1
Ease to Acquire Easements	4
Technical Complexity	4
Administrative Effort	2
Total	**30**
Total Benefits: $202,000	
Total Costs: $1,570,000 (Range: $783,000 to $3,130,000)	
Benefit-Cost Ratio (BCR)	0.13

For this alternative, WEC assumed that a pier would be needed at the mid-span of the proposed bridge and that the width of the current channel would be maintained so as not to cause sedimentation issues. Therefore, the widened span would span not the channel, but the floodplain. Exhibit 4e in Appendix A provides a conceptual rendering of this proposed alternative as well as the modeled reduction in flood inundation extents at the base flood elevation.

Hydraulic Analysis: To model the flood risk reduction resulting from this flood mitigation alternative, WEC developed a proposed conditions hydraulic model in which the two-span, widened bridge was integrated. In addition, model cross-sections upstream and downstream of the bridge were modified to provide a floodplain bench to increase floodplain conveyance throughout the reach. Table 4-12 summarizes the modeled reduction in water surface elevations for this alternative and Figure 4-4 provides a depiction of this widened bridge in the hydraulic model for this alternative. In general, the modeled reductions in water surface elevations are twice that of Alternative 4, with water surface reductions of three to nine inches expected for more infrequent floods at Winco Park, the Greene County Highway Garage, and Van Etten Trucking.

Table 4-12
Summary of Alternative 5 Flood Risk Reduction

Location	Model XS	Modeled Reduction in Water Surface Elevation (ft)			
		50pct ACE	**10pct ACE**	**1pct ACE**	**0.2pct ACE**
At County Road 17	8.87412	+0.05	-0.10	-1.59	-0.88
Country Suites	9.04031	+0.02	-0.35	-0.76	-0.54
Winco Park	9.12127	0.00	-0.32	-0.66	-0.50
Greene Cnty Garage	9.24249	0.00	-0.08	-0.34	-0.30
Van Etten Trucking	9.36244	0.00	-0.03	-0.19	-0.19
Near EZ Tire	9.55176	0.00	0.00	0.00	0.00

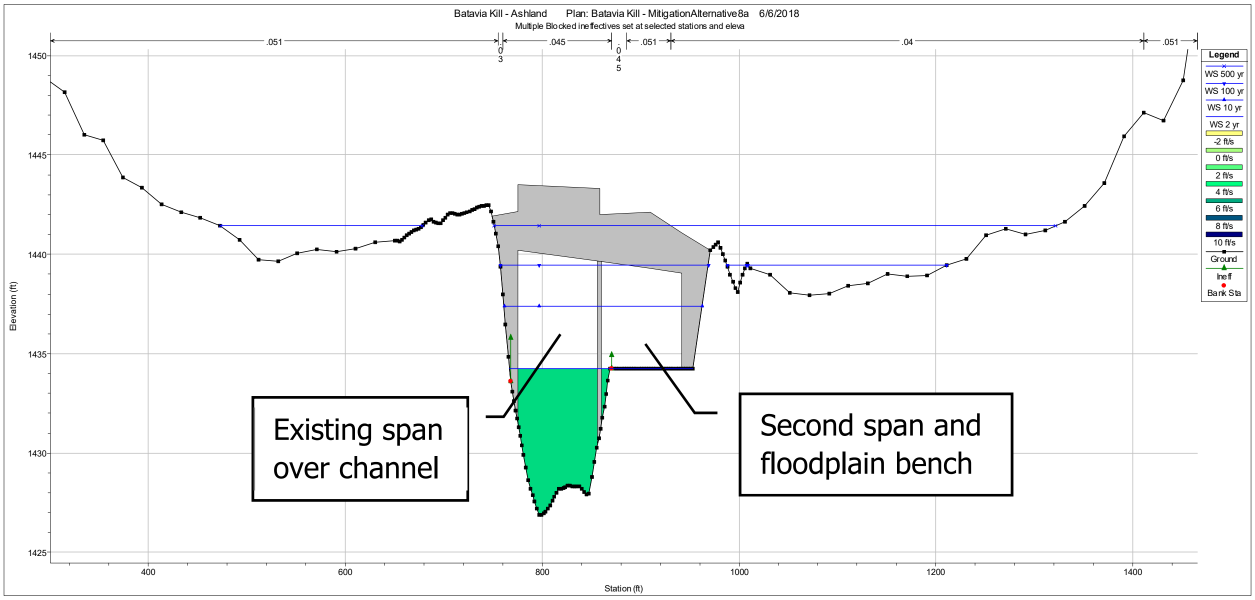

Figure 4-4: Representation of Alternative 5 in Hydraulic Model

Benefit-Cost Analysis: Given that the intent of this alternative was to justify funding of a widened span the next time the bridge is to be replaced, WEC performed a Benefit-Cost Analysis for this alternative. No special adjustments to the assumptions summarized in Section 4.1.3 were made for this alternative. For the cost estimate, WEC assumed the per-square-foot cost of the new bridge would be identical to the per square-foot cost of the recently-constructed replacement County Road 17 bridge. As the proposed bridge is twice as wide as the existing bridge, the cost of the proposed bridge would be twice that of the existing bridge. Further, GCSWCD requested that only the *additional* cost of the widening be considered in the calculations on the assumption that traditional bridge funding will be used to fund the reconstruction of the existing span. With these assumptions, the cost of *only* the widened span would be equal to the cost of the recently re-constructed bridge. Calculated project costs and benefits are reported in Table 4-11; a detailed cost estimate is provided as Exhibit 2 of Appendix B. The calculated BCR for this alternative is 0.13, which is less than 1.0 and therefore an ineffective use of public dollars *solely* for flood risk reduction benefits at this time. However, the calculated benefits would be the justified expenditure for solely flood risk reduction which may prove useful for future funding.

Feasibility Assessment: Although the calculated BCR for this alternative is not currently favorable, a feasibility assessment has been quantified in Table 4-9 to support GCSWCD's objectives for this alternative.

Additional Studies: Prior to advancing to the design of a bridge improvement, WEC recommends a detailed feasibility study prior to beginning design of the proposed improvement. This feasibility assessment should include an updated survey of the bridge, its approach, and adjacent channel and floodplain grades, an updated hydraulic analysis using this new survey information to confirm the above analyses and address data gaps identified in Section 2.4, and an improved cost estimate that better reflects the unique characteristics of this project site.

4.7 Alternative 6 – Floodplain Reclamation above WWTP

Following completion of the Corrected Effective Model, WEC performed a detail review of the model results to identify locations where water surface elevations increase more quickly than in other portions of the study reach (Figure 4-5). These locations are frequently where increased energy is required to convey the streamflow, often the result of channel constrictions or other factors which reduce the hydraulic efficiency of the stream.

Table 4-13
Summary Metrics for Alternative 6

Priority Metric	Score
Water Quality Protection	N/C
Downstream and Upstream Benefits /Impacts	N/C
Public Benefit	N/C
Community Cohesion Preservation	N/C
Ease of Obtaining Permits for Proposed Solution	N/C
Economic Impact	N/C
Ease of Obtaining Funding	N/C
Ease to Acquire Easements	N/C
Technical Complexity	N/C
Administrative Effort	N/C
Total	**N/C**
Total Benefits: < $13,000	
Total Costs: N/C	
Benefit-Cost Ratio (BCR)	**N/C**

One such location that was observed was the area immediately upstream of the Ashland WWTP. As shown in Exhibit 2a, the floodplain along the existing agricultural field upstream of the Ashland WWTP is relatively disconnected compared to the upstream and downstream reaches (note the constriction in the red hatching which is the 10 percent ACE). Given the rapid increase in water surface elevation at this location seen in Figure 4-5, WEC developed an alternative, illustrated in Exhibit 4f, to reconnect this floodplain with the goal to decrease flood risk upstream towards the hamlet of Ashland.

Hydraulic Analysis: To assess the degree to which reconnecting this floodplain would decrease water surface elevations and flood risk to upstream residents, WEC developed a proposed conditions hydraulic model that removed existing ground in this floodplain area to approximately the elevation of the 50 percent ACE event. Based on the modeling results for this alternative summarized in Table 4-14, significant reductions in water surface elevations of over three feet would be expected. However, these benefits mostly occur at structures that are already well-elevated about expected flood levels such that there is relatively little existing flood risk to mitigate. The hydraulic benefits of the project mostly dissipate by the Ashland hamlet.

Table 4-14
Summary of Alternative 6 Flood Risk Reduction

Location	Model XS	Modeled Reduction in Water Surface Elevation (ft)			
		50pct ACE	10pct ACE	1pct ACE	0.2pct ACE
Upstream of WWTP	5.80492	0.00	+0.02	+0.01	+0.01
Sugarloaf Stables	6.2981	+0.15	-0.22	-2.36	-3.16
Ashland Tire Lube	6.37022	+0.09	-0.23	-1.37	-2.18
Gravel Pit Bridge	6.61309	0.00	-0.04	-0.15	-0.55
Near Post Office	6.79085	0.00	0.00	0.00	0.00

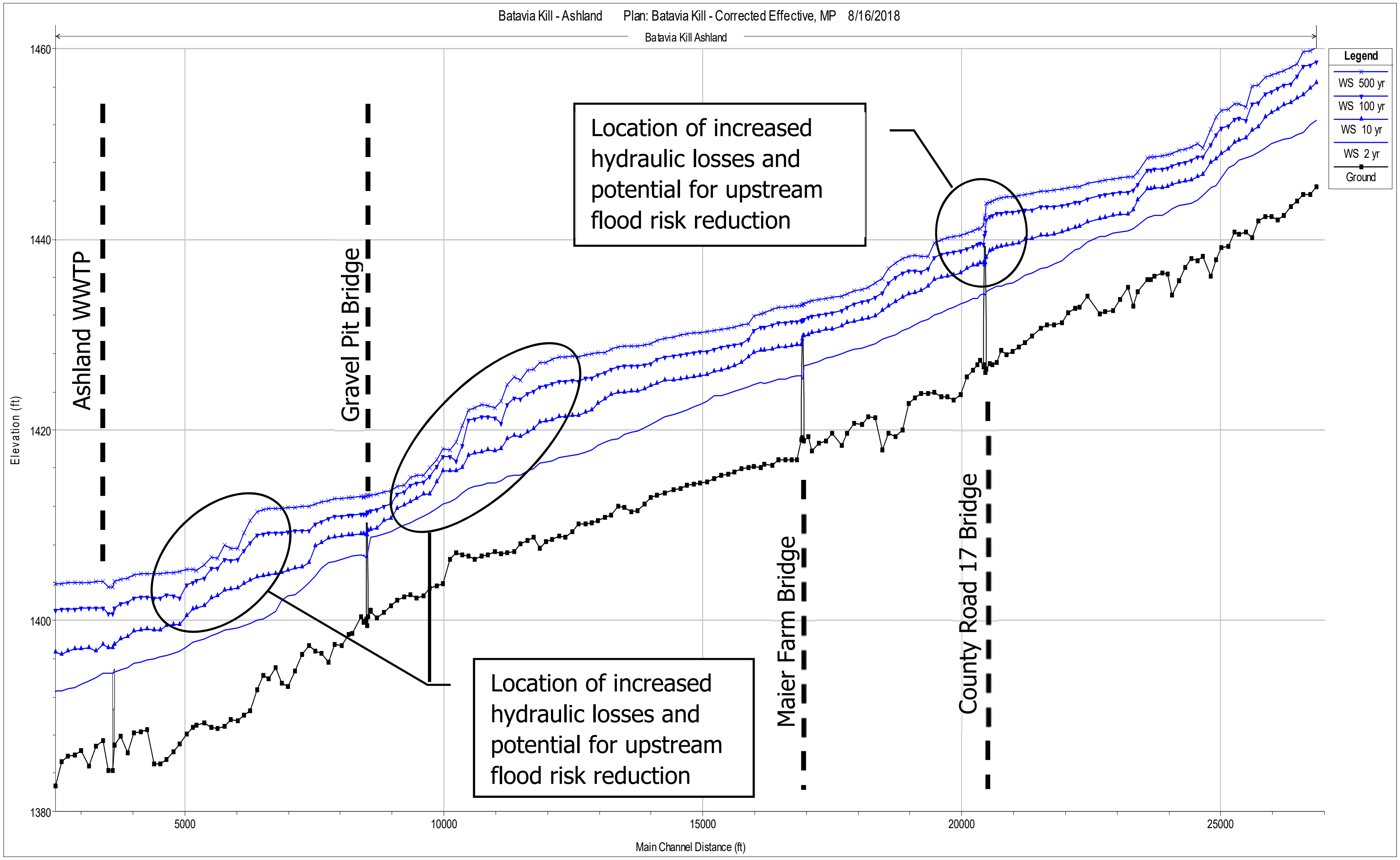

Figure 4-5: Corrected Effective Model Results and Locations of Increased Hydraulic Losses

Benefit-Cost Analysis: To assess the best-case scenario of potential project benefits, WEC consolidated the anticipated acquisition benefits for the structures (see Section 4.14 additional details of this calculation) that would benefit from the proposed alternative. As the acquisition benefits would be maximized because all future flooding costs would be avoided, this technique over-estimates the potential benefits of the proposed floodplain reclamation alternative. As the over-estimated benefits are only $13,000 and the cost of a floodplain reclamation project is likely to be at least in the hundreds of thousands of dollars, the project was assumed to have a BCR well below 1.0 and no cost estimate or BCR was calculated.

Feasibility Assessment: Given the above considerations, no feasibility assessment was performed for this alternative.

4.8 Alternative 7 – Floodplain Bench near Ashland Town Park

A flood mitigation alternative that was identified in the public outreach process based on WEC's field observations was the excavation of a floodplain bench alongside the Ashland Town Park. This alternative was proposed as there was the potential for a public-private partnership in which the material excavated for the project may have value as fill (given the proximity of the gravel mine to this location). As such, there is an opportunity that a public benefit could be achieved from privately-profitable operation. The conceptual rendering and anticipated decrease in water surface elevations for this alternative are provided in Exhibit 4g.

Table 4-15
Summary Metrics for Alternative 7

Priority Metric	Score
Water Quality Protection	N/C
Downstream and Upstream Benefits /Impacts	N/C
Public Benefit	N/C
Community Cohesion Preservation	N/C
Ease of Obtaining Permits for Proposed Solution	N/C
Economic Impact	N/C
Ease of Obtaining Funding	N/C
Ease to Acquire Easements	N/C
Technical Complexity	N/C
Administrative Effort	N/C
Total	**N/C**
Total Benefits: < $8,000	
Total Costs: N/C	
Benefit-Cost Ratio (BCR)	**N/C**

Hydraulic Analysis: To assess the degree to which the proposed floodplain bench would decrease water surface elevations and flood risk to the adjacent Hamlet of Ashland, WEC developed a proposed conditions hydraulic model that removed existing ground in this floodplain area to approximately the elevation of the 50 percent ACE event. Based on the modeling results for this alternative summarized in Table 4-16, moderate reductions in water surface elevations of a few inches would be expected. Upon review of this model results, the floodplain is already well-connected at higher discharges and additional excavation yields relatively little flood risk reduction.

Benefit-Cost Analysis: To assess the best-case scenario of potential project benefits, WEC consolidated the anticipated acquisition benefits for the structures (see Section 4.14 additional details of this calculation) that would benefit from the proposed alternative. As the acquisition benefits would be maximized because all future flooding costs would be avoided, this technique over-estimates the potential benefits of the proposed floodplain reclamation alternative. As the over-estimated benefits are only $8,000 and the cost of a floodplain reclamation project is likely to be many times that cost, the project was assumed to have a BCR well below 1.0 and no cost estimate or BCR was calculated. However, should a private entity wish to excavate this material, flood reduction benefits may be realized.

Feasibility Assessment: Given the above considerations, no feasibility assessment was performed for this alternative.

Table 4-14
Summary of Alternative 7 Flood Risk Reduction

Location	Model XS	Modeled Reduction in Water Surface Elevation (ft)			
		50pct ACE	10pct ACE	1pct ACE	0.2pct ACE
Near W Settlement Rd	6.71953	+0.02	-0.04	+0.03	-0.03
Near post office	6.81466	0.00	-0.10	-0.11	-0.11
Near Sutton Hollow	6.97945	+ 0.02	-0.20	0.00	+0.01
u/s GCSWCD project	7.14635	+0.01	-0.06	0.00	0.00

4.9 Alternative 8 – Floodplain Reclamation below Carrington Road

Another location that was identified via Exhibit 4-5 as an area of increased hydraulic losses was the area upstream of the Hamlet of Ashland and downstream of the Carrington Road neighborhood. As shown in Exhibit 2b and Exhibit 2c, the floodplain along this agricultural property upstream of the Hamlet of Ashland and across the river from the gravel pit is relatively disconnected compared to the upstream and downstream reaches (note the constriction in the red hatching which is the 10 percent ACE). Given the rapid increase in water surface elevation at this location seen in Figure 4-5, WEC developed an alternative, illustrated in Exhibit 4h, to reconnect this floodplain with the goal to decrease flood risk upstream in the Carrington Road neighborhood.

Table 4-17
Summary Metrics for Alternative 8

Priority Metric	Score
Water Quality Protection	N/C
Downstream and Upstream Benefits /Impacts	N/C
Public Benefit	N/C
Community Cohesion Preservation	N/C
Ease of Obtaining Permits for Proposed Solution	N/C
Economic Impact	N/C
Ease of Obtaining Funding	N/C
Ease to Acquire Easements	N/C
Technical Complexity	N/C
Administrative Effort	N/C
Total	**N/C**
Total Benefits: < $36,000	
Total Costs: N/C	
Benefit-Cost Ratio (BCR)	**N/C**

Hydraulic Analysis: No hydraulic modeling of this alternative was performed due to the Cost-Benefit Analysis summarized below.

Benefit-Cost Analysis: To assess the best-case scenario of potential project benefits, WEC consolidated the anticipated acquisition benefits for the structures (see Section 4.14 additional details of this calculation) that would benefit from the proposed alternative. As the acquisition benefits would be maximized because all future flooding costs would be avoided, this technique over-estimates the potential benefits of the proposed floodplain reclamation alternative. As the over-estimated benefits are only $36,000 and the cost of a floodplain reclamation project is likely to be at least in the hundreds of thousands of dollars, the project was assumed to have a BCR well below 1.0 and no cost estimate or BCR was calculated.

Feasibility Assessment: Given the above considerations, no feasibility assessment was performed for this alternative.

4.10 Alternative 9 – Relocation of Greene County Highway Garage

The Greene County Highway Garage in Ashland is a critical community facility as the garage is used for the following critical functions:

- Re-fueling of emergency response vehicles
- Operating center for dispatch of department personnel for disaster response, including closing down public roads during a disaster that may threaten public safety
- Storage of highway maintenance equipment needed to re-open roadways after disasters

Table 4-18
Summary Metrics for Alternative 9

Priority Metric	Score
Water Quality Protection	3
Downstream and Upstream Benefits /Impacts	3
Public Benefit	5
Community Cohesion Preservation	3
Ease of Obtaining Permits for Proposed Solution	5
Economic Impact	3
Ease of Obtaining Funding	4
Ease to Acquire Easements	4
Technical Complexity	5
Administrative Effort	4
Total	**39**
Total Benefits: $731,000	
Total Costs: $2,920,000 (Range: $1,460,000 to $5,840,000)	
Benefit-Cost Ratio (BCR)	**0.25**

In the event of a flood, these critical functions may be delayed or suspended as the facility, and the significant equipment stored there, is damaged or unable to be accessed. If this were to occur, the risk to public safety would be increased. Considering the facility was flooded in 1996, 1999, and 2011, protection of this facility was identified as a primary concern by the FAC. Fortunately, only nuisance-level damages were incurred in the 1996 and 1999 flood. However, the damage in 2011 was more significant and required several month's rental of a temporary office when repairs were made. However, additional damage was avoided in 2011 as the Batavia Kill peaked during waking hours when staff were working or readily accessible. This allowed the department staff to mobilize and move equipment out of harm's way prior to flooding of the facility. However, if the equipment had not been moved, flooding of the Greene County Highway Garage during Hurricane Irene could have led to the loss of millions of dollars of equipment.

The first alternative developed by WEC and the FAC to protect this critical community facility was its complete relocation to a location outside of the floodplain. This alternative would eliminate the risk of future flooding and ensure that flooding of the facility would not constrain the facility's critical operations during a disaster.

Hydraulic Analysis: As the proposed facility would be relocated outside of the floodplain, no hydraulic modeling of this alternative was performed.

Benefit-Cost Analysis: To assess the anticipated benefits of relocating the Greene County Highway Garage, WEC utilized FEMA's Benefit-Cost Analysis Toolkit to calculate the alternative as an acquisition which would include as part of the benefits all avoided flooding costs resulting from relocating the facility. The key difference from a traditional acquisition is the costs of this alternative would include construction of a comparable facility at a new location within the Town of Ashland; these costs are detailed in Exhibit 3 of Appendix B. The following special procedures beyond those summarized in Section 4.1.3 were utilized to calculate the BCR for this alternative:

- Approximate total salary for facility staff, provided by Deputy Superintendent Tom Hoyt, were included to estimate the value of services that would be lost during a flood; and,

- Contents costs were custom-entered to reflect the replacement value of trucks and maintenance equipment stored at the garage; this information was provided Mr. Hoyt.

The calculated BCR of 0.25 is significantly less than 1.0 to qualify the project for many grant funding sources related solely to flood risk reduction. However, the critical nature of this project and the unquantified benefits the facility provides provide additional justification to further this alternative and potentially solicit funding. In addition, as the facility continues to age, the Greene County Highway Department may choose to improve or repair the structure. If this decision is to occur, it is possible that flood risk reduction funding could be used to supplement funding from Greene County to fund the relocation of the facility to a new location outside of the floodplain.

Feasibility Assessment: Although the calculated BCR for this alternative is not currently favorable, a feasibility assessment has been completed to quantify other metrics and the feasibility of implementing the project due to its critical function. WEC's opinion of feasibility metrics for this alternative are provided in Table 4-9. Key points are summarized below:

- Re-location of the facility would mitigate two or more water quality pollution sources (the salt shed and vehicle storage barn);
- A public benefit would be provided as flooding would no longer constrain the ability of the facility to provide its critical function; and
- As a critical community facility, the proposed alternative is more likely to qualify for funding which could supplement highway department funding for a replacement facility.

Additional Studies: Pending funding opportunities, additional benefits provided by this alternative could be quantified including environmental benefit by converting the parcel to conservation land, flood risk reduction benefits to adjacent structures by removing any placed fill or obstructions, and public benefits via improved services. Should the improvement or replacement of this facility advance independently, the proposed flood risk reduction should be re-evaluated to identify opportunities to fund the relocation of the facility to a location with less flood-risk.

4.11 Alternative 10 – Protective Levee at Highway Garage and Winco Park

The second alternative developed by WEC and the FAC to protect the critical Greene County Highway Garage facility was the construction of a protective levee. This alternative would significantly reduce the risk of future flooding and reduce the risk that flooding of the facility would constrain the facility's critical operations during a disaster. As the facility extends significantly into the floodplain of the Batavia Kill, the proposed levee was extended to also protect Winco Park and adjacent businesses, as the benefits of this additional length of the levee to protect these additional structures was assumed to outweigh the costs associated with it. A conceptual rendering of this alternative and its anticipated impact to inundation extents at the base flood elevation is provided in Exhibit 4i.

Table 4-19
Summary Metrics for Alternative 10

Priority Metric	Score
Water Quality Protection	5
Downstream and Upstream Benefits /Impacts	2
Public Benefit	5
Community Cohesion Preservation	4
Ease of Obtaining Permits for Proposed Solution	3
Economic Impact	3
Ease of Obtaining Funding	2
Ease to Acquire Easements	1
Technical Complexity	3
Administrative Effort	3
Total	**31**
Total Benefits: $816,000	
Total Costs: $1,720,000 (Range: $860,000 to $3,440,000)	
Benefit-Cost Ratio (BCR)	**0.47**

Hydraulic Analysis: To model the change in flood risk from this alternative, WEC developed a proposed conditions hydraulic model in which the proposed levee was modeled with the "levee" feature in HEC-RAS. The proposed levee was set three feet above the base flood elevation in conformance with FEMA accreditation standards. As no structures would be adversely impacted by the levee (all nearby structures would be protected by the levee), no additional flood mitigation offsets (i.e. floodplain benches etc. on the riverward side of the levee) to limit increases to the base flood elevation was included in the hydraulic model at this time (but could be in future iterations). As summarized in Table 4-20, the proposed levee would increase water surface elevations in the vicinity of the levee a few inches; however, there would be a negligible increase upstream of the levee (near EZ Tire).

Table 4-20
Summary of Alternative 10 Flood Risk Change

Location	Model XS	Modeled Reduction in Water Surface Elevation (ft)			
		50pct ACE	10pct ACE	1pct ACE	0.2pct ACE
Country Suites*	9.04031	0.00	-0.01	-0.04	-0.08
Winco Park*	9.12127	0.00	0.00	+0.08	+0.17
Greene Cnty Garage*	9.24249	0.00	-0.01	+0.11	+0.31
Van Etten Trucking*	9.36244	+0.16	+0.25	+0.15	+0.42
Near EZ Tire*	9.55176	0.00	0.00	0.00	+0.02

* Protected by proposed levee

Benefit-Cost Analysis: To assess the anticipated benefits of constructing a levee to protect the Greene County Highway Garage, Winco Park, and adjacent structures, WEC utilized FEMA's Benefit-Cost Analysis Toolkit to calculate the benefits of avoided flooding costs resulting from protection of the facility and adjacent structures. The following special considerations beyond those summarized in Section 4.1.3 were utilized to calculate the BCR for this alternative:

- Approximate total salary for facility staff, provided by Deputy Superintendent Tom Hoyt, were included to estimate the value of services that would be lost during a flood;
- Maintenance costs, which must be funded by the Town, were liberally excluded, and,
- Contents costs were custom-entered to reflect the replacement value of trucks and maintenance equipment stored at the garage; this information was provided by Mr. Hoyt.

The calculated BCR of 0.47 is less than 1.0 to qualify the project for most external funding sources related solely to flood risk reduction. Incorporation of maintenance costs, which would have to be fully-borne by the Town and/or County, would further reduce the calculated BCR. The BCR of the project may be improved by reducing the height of the proposed levee to reduce the cost of the project if most of the anticipated flood mitigation benefits resulted from flood avoidance at more frequent discharges.

Feasibility Assessment: Although the calculated BCR for this alternative is not currently favorable, a feasibility assessment has been completed to quantify other metrics and the feasibility of implementing the project due to its critical function. WEC's opinion of feasibility metrics for this alternative are provided in Table 4-9. Key points are summarized below:

- The proposed berm would mitigate 26 or more water quality pollution sources (the salt shed, vehicle storage barn, 20 residences, and 4 businesses);
- A public benefit would be provided as flooding would no longer constrain the ability of the facility to provide its critical function;
- The proposed levee would eliminate flood storage currently available, and thus may increase downstream flood risk;
- The proposed levee would constrain the overall floodplain, leading to increased channel velocities and possibly increasing the erosion risk within this reach;
- Winco Park has been identified as an important residential area for the community; protection of this area was deemed to provide a community cohesion benefit;
- Construction of a levee to FEMA standards would likely result in the conversion of the protected area from a Zone AE Special Flood Hazard Area to an unshaded Zone X, which would decrease flood insurance rates and eliminate the requirement for flood insurance on Federally-backed mortgages;
- As a critical community facility, the proposed alternative is more likely to qualify for funding which could supplement highway department funding for a replacement facility; however, the Catskill Watershed Corporation and DEP do not fund flood control structures including levees, berms, and flood walls. Further, as most of the Federal funding sources require a BCR in excess of 1.0 to fund such a project, external funding opportunities for this opportunity are more limited than for any other alternative.

Additional Studies: Prior to advancement of this alternative, unsteady hydraulic modeling should be performed to assess the impact that the loss of floodplain storage would have on downstream discharges and thus flood risk. If the modeled impact is significant, the Benefit-Cost Analysis for the project should be re-analyzed to include the flood risk costs associated with these downstream impacts. In addition, following this analysis, maintenance costs should be integrated into detailed benefit-cost analyses performed for a suite of levee heights to advance the proposed levee design that provides the greatest BCR.

4.12 Alternative 11 – State Route 23 Profile Rise

Table 4-21 Summary Metrics for Alternative 11	
Priority Metric	Score
Water Quality Protection	N/C
Downstream and Upstream Benefits /Impacts	N/C
Public Benefit	N/C
Community Cohesion Preservation	N/C
Ease of Obtaining Permits for Proposed Solution	N/C
Economic Impact	N/C
Ease of Obtaining Funding	N/C
Ease to Acquire Easements	N/C
Technical Complexity	N/C
Administrative Effort	N/C
Total	**N/C**
Total Benefits: N/C	
Total Costs: N/C	
Benefit-Cost Ratio (BCR)	**N/C**

Another riverine / infrastructure flood hazard that was identified both by the Corrected Effective Model and the public was the overtopping of State Route 23 downstream of the Ashland WWTP. During Hurricane Irene, this portion of State Route 23 was closed for less than 10 hours. State Route 23 was re-opened without incident, but an estimated 11,000 cubic yards, equivalent to approximately 1,000 loaded dump trucks, was eroded from the channel and the floodplain adjacent to the Holden Property opposite of State Route 23. While portions of State Route 23 downstream of this location were severely impacted, these areas were located in the Town of Prattsville and outside of the LFHMP studies.

In developing an alternative to address the flooding-induced closure of State Route 23 downstream of the Ashland WWTP, WEC conferred with the DOT. DOT stated that given the limited repairs that were necessary (limited repair of placed stone protection) and limited closure, this location was not their greatest concern along State Route 23. As such, they anticipated the benefit of the improving this portion of roadway to be limited and not justified until other improvements, particularly related to landslides that occurred within Prattsville, occur.

Hydraulic Analysis: No additional hydraulic modeling of this alternative was performed. However, WEC reviewed the Corrected Effective Model to quantify the depth and frequency at which State Route 23 would be flooded during the base flood elevation. The modeled depth was as great as 2.5 feet along parts of the road; this is a sufficient depth to damage cars and possibly cause fatalities if a car were to attempt to ford the road crossing. Based on the hydraulic modeling results, inundation of this portion of State Route 23 would be expected to occur sometime between a 2- and 4-percent ACE.

Benefit-Cost Analysis: Considering discussions with DOT that the road was closed for a limited period of time and was not the key factor constraining emergency response vehicles, the BCR for this alternative was assumed to be considerably less than 1.0 and no benefit-cost analysis was performed.

Feasibility Assessment: Given the above considerations, no feasibility assessment was performed for this alternative.

Additional Studies: While raising the profile of Route 23 is unlikely feasible, inundation of the roadway is expected based on results of the Corrected Effective Model. Therefore, WEC recommends that Town staff be prepared to implement a road closure at this location during future high-flow events. If inundation of the roadway is frequent, WEC recommends re-consideration of this alternative or installation of signage to identify the recurrent flood hazard.

4.13 Alternative 12 – Structure Elevations

Table 4-22 Summary Metrics for Alternative 12	
Priority Metric	Score
Water Quality Protection	2
Downstream and Upstream Benefits /Impacts	3
Public Benefit	3
Community Cohesion Preservation	3
Ease of Obtaining Permits for Proposed Solution	5
Economic Impact	4
Ease of Obtaining Funding	5
Ease to Acquire Easements	5
Technical Complexity	4
Administrative Effort	3
Total	**37**
Total Benefits: Varies by structure	
Total Costs: Varies by structure	
Benefit-Cost Ratio (BCR)	**Varies**

Where other flood mitigation project types (described in Section 4.1.1) are not feasible or may not be funded, structure elevations and other property protection projects provide an alternative to decrease the flood risk to individual structures. In the case of structure elevations, the building structure would be removed from the basement or foundation, elevated to a height above the base flood elevation, and reset on a new foundation. The elevated height of livable areas would decrease the frequency of flooding and flood damage during a particular event. How a structure is elevated depends significantly upon the type of construction and how high the structure is to be elevated. Figure 4-6 provides a FEMA infographic that illustrates structure elevation with a wet floodproofed addition, but piers, piles, dry flood-proofed perimeter walls, and other methods may also be used. For the LFHMP, WEC assessed the potential benefits of structure elevation at flood-prone structures.

Hydraulic Analysis: It was assumed that any structural elevation would have negligible impact on flood hydraulics such that only the results of the Corrected Effective Model were used as input to the Benefit-Cost Analysis tool to calculate avoided damage costs for each structure.

Figure 4-6: Infographic of Structure Elevation; Source: FEMA

Benefit-Cost Analysis: The cost of elevating a structure is specific to each individual structure as the cost is dependent on the height the structure is to be raised, the structure's construction, the condition of its foundation, the interconnection of utilities, and several other factors. In this planning level study, WEC conferred with regional structure elevation contractors to establish a cost per square foot for a typical wood-frame construction with good foundation that is to be raised three feet. BCRs for each individual flood-prone structure are summarized in Exhibit 5 of Appendix B. Estimated BCRs range from 0.00 (negligible benefit from elevation) to as much as 1.29. Only one structure was estimated to have a BCR in excess of 1.0 that may benefit from elevation.

In addition to the Benefit-Cost Analysis calculation above, WEC also evaluated the cost of elevating the structure in comparison to FEMA's pre-calculated benefits for structure elevation. Based on FEMA's analysis of 11,000 acquisition and elevation projects, FEMA allows the use of pre-calculated benefits of $175,000 to be used when a structure is located in a Special Flood Hazard Area or has a finished floor elevation below the base flood elevation. In such cases, an elevation project would be considered cost-effective if the calculated costs are less than $175,000. Using this simplified criteria, 28 structures qualify as cost-effective for elevation.

However, WEC would caution the use of this simplified criteria to fund elevation projects for projects with calculated BCRs significantly less than 1.0 as provided in Exhibit 5 of Appendix B. Considering the calculated BCRs, WEC would recommend elevation of only structure number 126 identified in Exhibit 5 of Appendix B.

Feasibility Assessment: WEC prepared a feasibility assessment provided in Table 4-22 for this alternative presuming a favorable BCR. However, this feasibility matrix may vary for individual structures. Key points to consider are summarized below:

- In addition to reduction of flood damages, the increased structure elevation would reduce the flood insurance rates for those properties located within a Special Flood Hazard Area;
- For purposes of the feasibility assessment, water quality hazards were assumed to be mitigated as elevation would reduce the frequency at which household chemicals and other quality hazards stored within a home were inundated. However, septic tanks, cars, and oil tanks may continue to be inundated.

Recommended Studies: As the cost of elevating a structure is specific to each individual structure, a structure-specific study should be conducted to confirm the BCR for the elevation of each structure prior to implementation of construction. For those properties that meet the simplified FEMA requirements for use of pre-calculated benefits, WEC recommends a detailed feasibility study be performed to assess the elevation costs against anticipated benefits for that particular structure to confirm that an acceptable BCR is achieved prior to applying for funding.

4.14 Alternative 13 – Structure Acquisitions

In addition to structure elevations, structure acquisitions are another type of property protection project that can decrease the flood risk to individual structures. By acquiring the structure, the future costs of flood damage to the structure are entirely eliminated. It should be noted that structure acquisitions cannot progress without the approval of the landowner; no entity has the authority to acquire a house solely for flood risk reduction purposes from an unwilling landowner. Also, given the sensitivity of this information, identifying information of structures has been withheld from public distribution at the request of the Town Board.

Table 4-23 Summary Metrics for Alternative 13

Priority Metric	Score
Water Quality Protection	2
Downstream and Upstream Benefits /Impacts	3
Public Benefit	3
Community Cohesion Preservation	2
Ease of Obtaining Permits for Proposed Solution	5
Economic Impact	2
Ease of Obtaining Funding	5
Ease to Acquire Easements	5
Technical Complexity	5
Administrative Effort	2
Total	**34**
Total Benefits: Varies by structure	
Total Costs: Varies by structure	
Benefit-Cost Ratio (BCR)	**Varies**

Hydraulic Analysis: As the benefit of structure acquisitions are dependent only on the estimated structure flood damages under current conditions, only the results of the Corrected Effective Model were used as input to the Benefit-Cost Analysis tool to calculate avoided damage costs for each structure.

Benefit-Cost Analysis: The cost of acquiring a structure is more universal than the cost of elevating a structure as the largest cost is generally the acquisition cost of the property which is correlated to the assessed value of the property. In this planning level study, WEC conferred with regional municipal engineers to quantify the hard costs, including demolition and re-seeding, and soft costs, including title research and administrative costs, of structure acquisition. BCRs for each individual flood-prone structure is summarized in Exhibit 6 of Appendix B. Estimated BCRs range from 0.01 (negligible benefit from elevation) to as much as 1.26. Only one structure was estimated to have a BCR in excess of 1.0 where the benefits of acquisition exceed the costs. Two additional structures have a BCR between 0.5 to 1.0 that, considering other unquantified benefits, may also have benefits that exceed their costs.

In addition to the Benefit-Cost Analysis calculation above, WEC also evaluated the cost-benefit of acquiring the structures in relation to FEMA's simplified pre-calculated benefits for structure acquisition. Based on FEMA's analysis of 11,000 acquisition and elevation projects, FEMA allows the use of pre-calculated benefits of $276,000 to be used when a structure is in a Special Flood Hazard Area or has a finished floor elevation below the base flood elevation. In such cases, an acquisition project would be considered cost-effective if the calculated costs are less than $276,000. Using this simplified criteria, 30 structures qualify as cost-effective for acquisition. However, WEC would caution the use of this simplified criteria to fund acquisitions for structures with calculated BCRs significantly less than 1.0 as provided in Exhibit 5 of Appendix B.

In addition to FEMA's simplified cost-benefit procedure, the New York City-Funded Flood Buyout Program (NYCFFBO) also has requirements that vary from a traditional benefit cost analysis. Per NYCFFBO program rules, structures are eligible for acquisition due to inundation if they are likely to be substantially damaged (flood damages exceed 50 percent of the current value of the structure) at an event with a 1 percent or more frequent chance of occurrence (100-year flood or smaller). Per this criteria, two structures would be eligible for acquisition. Considering the limitations of the above, WEC would recommend the Town consider acquisition of only structure numbers 126 (BCR = 1.26), 132 (BCR = 0.52; NYCFFBO-eligible), and 143 (BCR = 0.52; NYCFFBO-eligible) identified in Exhibit 5 of Appendix B.

Feasibility Assessment: WEC prepared a feasibility assessment provided in Table 4-22 for this alternative presuming a favorable BCR. However, this feasibility matrix may vary for individual structures. Key points to consider are summarized below:

- In addition to eliminating flood damages, the acquisition of the structure would eliminate the flood insurance rates paid for those structures in a Special Flood Hazard Area;
- Water quality hazards will be mitigated as acquisition of the property would remove household chemicals, oil, propane, etc., that pose water quality hazards; and,
- Structure acquisition runs the risk of reducing community cohesion as entire structures will be removed, requiring the residents or businesses to relocate elsewhere.

Recommended Studies: For willing property owners interested in acquisition, a revised Benefit-Cost Analysis should be performed to confirm that the anticipated cost of the acquisition given current market factors still justify the cost-effectiveness of acquiring the property.

4.15 Alternative 14 – Fuel Tank Anchoring

As heating fuels weigh less than water, fuel tanks are often buoyant when submerged as may occur during a flood. If not properly anchored to their foundations, fuel tanks may tip over or float off their foundations during a flood. In addition to the owner's cost of replacing a fuel tank displaced by floodwaters, such fuel tanks may become debris hazards that exacerbate flooding if they become lodged in downstream constrictions, water quality hazards if damaged, or possibly explosive or fire hazards if introduced to open flames which sometimes occurs during flood events. The above hazards can be mitigated by anchoring the fuel tank to an immovable foundation.

Table 4-24
Summary Metrics for Alternative 14

Priority Metric	Score
Water Quality Protection	2
Downstream and Upstream Benefits / Impacts	3
Public Benefit	3
Community Cohesion Preservation	3
Ease of Obtaining Permits for Proposed Solution	5
Economic Impact	3
Ease of Obtaining Funding	4
Ease to Acquire Easements	5
Technical Complexity	5
Administrative Effort	5
Total	**38**
Total Benefits: N/C	
Total Costs: N/C	
Benefit-Cost Ratio (BCR)	**> 1.0**

Hydraulic Analysis: As the hydraulic impacts of this alternative were anticipated to be negligible or difficult to quantify, no hydraulic modeling was performed.

Benefit-Cost Analysis: The Catskill Watershed Corporation has concluded the benefits of anchoring tanks within the 500-year floodplain outweigh the costs and as such fully-fund the anchoring of all tanks that hold up to 330 gallons of oil or 420 pounds of propane. Anchoring of tanks that are in excess of 500 gallons or cost in excess of $5,000 may also be fully-funded but require engineering designs and funding approval from the Catskill Watershed Corporation Board of Directors. As such, no benefit-cost analysis was performed.

Feasibility Assessment: WEC prepared a feasibility assessment provided in Table 4-24 for this alternative presuming a favorable BCR.

Additional Studies: For those property owners seeking Catskill Watershed Corporation funding to anchor their fuel tanks, a Tank Anchoring Program Application can be accessed at the following link:

http://cwconline.org/wp-content/uploads/2017/03/TankAnchoringApplication.pdf

Completed applications should be submitted to the Catskill Watershed Corporation:

Catskill Watershed Corporation
PO Box 569, 905 Main Street
Margaretville, NY 12455

To qualify for funding, applicants must be located within the 500-year floodplain (Zone A, Zone AE, or stippled Zone X in Exhibits 1A through Exhibits 1C of Appendix A). If there are any additional questions regarding the application process, potential applicants should contact the Town Code Enforcement Officer (518 734-3636) or John Mathiesen at the Catskill Watershed Corporation (845 586-1400) for additional information. Also note that all fuel within the tanks at the beginning of the anchoring process is preserved for the owner or replaced.

5.0 Local Flood Hazard Mitigation Plan

5.1 Funding Sources

Project funding is a common challenge for implementation of public flood mitigation projects. As local, state, and Federal governments incur significant costs following natural disasters and would benefit from the reduction or elimination of future flood damage costs, several funding opportunities are available from these entities to decrease the financial burden of flood risk mitigation projects to communities or individual property owners. The following subsections describe potential Federal, state, local, and private funding sources that can be used to supplement local or individual funding to implement projects recommended for advancement in subsequent sections of this LFHMP.

5.1.1 Federal

1. **FEMA Hazard Mitigation Grant Program (HMGP)**
    - *Purpose:* Implementation of cost-effective hazard mitigation measures to reduce the risk of loss of life and property. Measures include structure acquisitions, structure elevations, structure relocation and/or reconstruction, hazard mitigation planning, floodproofing of historic properties, green infrastructure, and structural retrofits.
    - *Cost Share:* Up to 75% funding of project costs
    - *Eligibility:* State, local, and tribal governments and private non-profits, only after declaration of a Presidentially-declared Major Disaster
2. **FEMA Flood Mitigation Assistance (FMA)**
    - *Purpose:* Reduce or eliminate the risk of repetitive flood damage to structures insurable under the National Flood Insurance Program through advance planning, community-flood mitigation planning and projects, technical assistance, flood mitigation planning, and individual property mitigation projects.
    - *Cost Share:* Up to 75% funding of project costs, limited to $100,000 for community flood mitigation advance assistance, $10,000,000 for community flood mitigation projects, and $25,000 for local mitigation planning. Cost shares of 90% and 100% for Repetitive Loss and Severe Repetitive Loss properties, respectively.
    - *Eligibility:* State, local, and tribal governments having a Hazard Mitigation Plan
3. **FEMA Pre-Disaster Mitigation (PDM) Grant**
    - *Purpose:* Planning and projects to reduce natural hazard risk to populations and structures and avoid use of future Federal funding following disasters.
    - *Cost Share:* Up to 75% funding of project costs; up to 90% for impoverished communities with population of less than 3,000.
    - *Eligibility:* State, local, and tribal governments having a Hazard Mitigation Plan
4. **FEMA Repetitive Flood Claims Grant**
    - *Purpose:* Reduction or elimination of long-term flood risk to structures insured under the National Flood Insurance Program that have had one or more claim payments for flood damages.
    - *Cost Share:* Up to 100% funding of project costs
    - *Eligibility:* State, local, and tribal governments unable to provide the local cost share for FEMA's Flood Mitigation Assistance program.

5. **FEMA Risk Mapping, Assessment, and Planning Program (Risk MAP)**
    - *Purpose:* Identification of flood risk and promoting planning and development practices to reduce future flood risk.
    - *Cost Share:* Up to 100% funding of project costs.
    - *Eligibility:* Municipalities administering the minimum requirements of the National Flood Insurance Program.
6. **FEMA Public Assistance Program**
    - *Purpose:* Assistance for debris removal, life-saving emergency protective measures, and the repair, replacement, or restoration of disaster-damaged publicly-owned facilities, and the facilities of certain private non-profits.
    - *Cost Share:* Not less than 75% funding of project costs
    - *Eligibility:* State, local, and tribal governments and private non-profits, only after declaration of a Presidentially-declared Major Disaster
7. **NRCS Emergency Watershed Protection – Recovery**
    - *Purpose:* Construction of economically-, environmentally-, and socially-sound flood recovery measures to safeguard lives and property as the result of a natural disaster. Debris removal, streambank repair, and erosion control are eligible provided the problems did not exist prior to the natural disaster.
    - *Cost Share:* Up to 75% funding of construction costs
    - *Eligibility:* Conservation Districts and Federal, state, local, and tribal governments
8. **NRCS Emergency Watershed Protection – Floodplain Easement**
    - *Purpose:* Removal and relocation of structures and subsequent restoration of lands that have been 1) damaged by floods in the previous year, 2) damaged by floods twice within the previous 10 years, or 3) would contribute to the restoration of flood storage and flow or control erosion.
    - *Cost Share:* Up to 100% funding
    - *Eligibility:* Private, local, or state property owners
9. **NRCS Watershed Protection and Flood Prevention**
    - *Purpose:* Design and construction of cost-effective projects to prevent erosion, flood damage, and sedimentation in watersheds up to 250,000 acres in which at least 20 percent of the project's benefits accrue to agriculture
    - *Cost Share:* Up to 100% up to a maximum of $5,000,000 without Congressional approval
    - *Eligibility:* Public agencies or non-profit organizations
10. **USACE Section 14 Emergency Streambank and Shoreline Protection**
    - *Purpose:* Study, design, and construction of economically-justified and environmentally-sound streambank protection works to protect public facilities (roads, bridges, water supply, wastewater treatment, etc.) and non-profit public facilities (churches, hospitals, etc.).
    - *Cost Share:* Up to 100% funding of feasibility studies up to $100,000; 50% thereafter. Up to 65% of design and construction costs. Total feasibility, design, and construction Federal cost share not to exceed $5,000,000 for any single project.
    - *Eligibility:* Public agencies or non-profit organizations

11. **USACE Section 205 Flood Damage Reduction Projects**
    - *Purpose:* Study, design, and construction of economically-justified, environmentally-sound, and technically-feasible small flood damage reduction projects including, but not limited to, channel improvements, floodplain modifications, and levees.
    - *Cost Share:* 100% funding of feasibility studies up to $100,000; 50% thereafter. Up to 65% of design and construction costs. Total feasibility, design, and construction Federal cost share not to exceed $10,000,000 for any single project.
    - *Eligibility:* Public agencies or non-profit organizations
12. **USACE Section 206 Aquatic Ecosystem Restoration Projects**
    - *Purpose:* Study, design, and construction of cost-effective projects in the public interest which restore aquatic ecosystems for fish and wildlife including, but not limited to, wetland restoration, river restoration, and dam removal.
    - *Cost Share:* 100% funding of feasibility studies up to $100,000; 50% thereafter. Up to 65% of design and construction costs. Total feasibility, design, and construction Federal cost share not to exceed $500,000 for any single project.
    - *Eligibility:* Public agencies or non-profit organizations
13. **USACE Section 208 Clearing and Snagging Projects**
    - *Purpose:* Study, design, and construction of channel clearing and excavation projects to reduce nuisance flooding caused by debris and minor shoaling of rivers that are economically-justified, environmentally-sound, and feasible.
    - *Cost Share:* 100% funding of feasibility studies up to $100,000; 50% thereafter. Up to 65% of design and construction costs. Total feasibility, design, and construction Federal cost share not to exceed $10,000,000 for any single project.
    - *Eligibility:* Public agencies or non-profit organizations
14. **US HUD Community Development Block Grant (CDBG)**
    - *Purpose:* Ensure decent, affordable housing for low- and moderate-income persons, prevent or eliminate slums or blight, and/or address community development needs that pose a serious and immediate threat to the health or welfare of the community (such as flooding).
    - *Cost Share:* Up to 100% of project costs
    - *Eligibility:* Local or state governments
15. **Federal Highway Administration Emergency Relief Program**
    - *Purpose:* Funds for the repair or re-construction of highways that have suffered serious damage as the result of a natural disaster or catastrophic events from an external cause.
    - *Cost Share:* Up to 80% of project costs, with several exceptions that allow up to 100% of project costs.
    - *Eligibility:* States may apply for funding for Federal-aid highways only

5.1.2 State

16. **DEC Flood Mitigation Grant**
    - *Purpose:* Flood debris removal and streambank stabilization and restoration
    - *Cost Share:* Up to 100% of project funding up to a maximum of $500,000
    - *Eligibility:* Municipalities

17. **DEC Trees for Tribs Program**
    - *Purpose:* Planting of trees along stream corridors to prevent erosion, increase flood storage, improve water quality, and improve aquatic and riparian habitat.
    - *Cost Share:* Up to 100% funding for plant materials and technical assistance
    - *Eligibility:* Property owners, municipalities, and conversation organizations
18. **DEC Water Quality Improvement Project Grant**
    - *Purpose:* Projects to reduce non-point source water pollution (e.g., excessive streambank erosion), restore aquatic habitat, or acquire lands for source water protection.
    - *Cost Share:* Up to 75% of project funding
    - *Eligibility:* Municipalities, municipal corporations, conservation districts, not-for-profit corporations, and regulated municipal separate storm sewer systems.
19. **Department of Labor Neighborhood Rebuilding Corps**
    - *Purpose:* Provision of labor to assist in flood recovery efforts
    - *Cost Share:* Up to $12,000 per temporary employee
    - *Eligibility:* Municipalities
20. **Department of Homeland Security and Emergency Services (DHSES) Emergency Management Performance Grants**
    - *Purpose:* State-administered Federal grants from FEMA to assist local governments in providing a system of emergency preparedness for the protection of life and property.
    - *Cost Share:* Up to 50% of project funding
    - *Eligibility:* Municipalities

5.1.3 Local

21. **Catskill Watershed Corporation Flood Hazard Mitigation Implementation Program**
    - *Purpose:* Funding of projects to decrease flood risk to residences, businesses, and/or communities and elimination of potential water quality hazards. Eligible projects include relocation assistance, alteration of public infrastructure, property protection measures, elimination of potential pollution sources, stream-related construction work, stream debris removal, and oil and propane tank anchoring. Structural flood control projects (levees, berms, floodwalls), stream dredging or channelization, and maintenance activities are ineligible.
    - *Cost Share:* Varies; generally 100%, but limited to 75% for property protection measures, community-wide pollution source elimination, and wastewater.
    - *Eligibility:* Municipalities; also property owners for property protection measures. Except for tank anchoring, stream debris removal, and relocation assistance for properties participating in the NYCFFBO, other projects need to be recommended in the community's LFHMP.
22. **Catskill Watershed Corporation Sustainable Community Planning Program**
    - *Purpose:* Funding of revisions to local zoning codes or zoning maps or to upgrade comprehensive plans to identify areas that can serve as new locations for residences and/or businesses after purchase under the NYCFFBO.
    - *Cost Share:* 100%, up to $20,000.
    - *Eligibility:* Municipalities with approved LFHMPs

23. **Greene County Soil and Water Conservation District Stream Management Implementation Program**
    - *Purpose:* Funding program for LFA communities to implement LFHMP recommendations that have off-site flood reduction benefits. Eligible projects include floodplain restoration and reconnection, stream restoration, infrastructure to reduce in-stream depth and/or velocity, and/or removal of hydraulic constrictions. Ineligible projects include flood walls, berms, or levees, dredging, routine annual maintenance, or replacement of privately-owned bridges, culverts, or roads.
    - *Cost Share:* Up to 100%
    - *Eligibility:* Municipalities with approved LFHMPs
24. **New York City-Funded Flood Buyout Program (NYCFFBP)**
    - *Purpose:* Acquisition of properties that are:
        - Supported by the local community and are:
            - Recommended by a hydraulic study (including a LFHMP);
            - Qualify for relocation assistance from the Catskill Watershed Corporation; or,
            - Recommended for implementation of the preferred alternative for a stream restoration project;
        - At risk of damage or destruction from erosion hazards;
        - Located within a Special Flood Hazard Area and at least has been previously flooded and experienced significant damage, but not necessarily Substantial Damage as defined by FEMA; or,
        - Have been previously flooded and can be relocated on the existing parcel outside of the 100-year and 500-year floodplain.
    - *Cost Share:* Up to 100%
    - *Eligibility:* Properties with willing property owners and, as noted above, supported by local communities.
25. **Flood Control and/or Drainage District**
    - *Purpose:* Creation of a Flood Control and/or Drainage District to fund the planning, implementation, and maintenance of projects to reduce flood risk and administer a public program to reduce flood risk damages. Formation of a Town Special District would be required to levy user fees and/or taxes to fund the costs of the District. In other parts of the country, Flood Control Districts have been used to fund enrollment in FEMA's Community Rating System that upon achievement of certain public information and floodplain management activities, can reduce flood insurance rates for local ratepayers and generate a net savings to individual property owners.
    - *Cost Share:* Not applicable
    - *Eligibility:* Not applicable

5.1.4 Private

26. **Individual Property Owners**
    - *Purpose:* While several funding sources are available to decrease financial burdens to individual property owners, individual property owners are able to self-finance any or all of the recommendations in this LFHMP.
    - *Cost Share:* Not applicable
    - *Eligibility:* No restrictions

27. **Not-for-Profit Corporations or Private Foundations**
   - *Purpose:* Where project benefits align with the goals of Not-for-Profit Corporations or private foundations, private funding could be used to fund portions of the project. Projects most likely to align with such organizations are those that have stated organizational goals to improve the environment.
   - *Cost Share:* Not applicable
   - *Eligibility:* Not applicable

5.2 Implementation and Prioritization Plan

As part of this study, WEC solicited input from the general public, local municipalities, and the Flood Advisory Committee to develop and evaluate 14 potential flood mitigation alternatives to reduce the flood risk to the Town of Ashland and its residents. On the basis of cost-effectiveness, project feasibility, availability of funding, and criticality of the structure, a subset of these flood mitigation alternatives were recommended for further consideration and/or advancement. These recommended flood mitigation alternatives and potential funding sources are summarized in Table 5-1.

Table 5-1
Prioritized List of Recommended Flood Mitigation Projects

Priority	Alternative	BCR	Feasibility Score	Funding Source
1	Alternative 9 - Relocation of Greene County Highway Garage	0.25	39	8, 18, 21, 22, 23, 25, 26
2	Alternative 14 – Fuel Tank Anchoring	> 1.0	38	21, 25, 26
3	Alternative 12 - Structure elevations [a]	Up to 1.29	37	2, 3, 14, 21, 25, 27
4	Alternative 13 - Structure acquisitions [b]	Up to 1.26	34	2, 3, 8, 21, 24, 25, 27
5	Alternative 4 - County Road 17 floodplain relief culverts [c]	0.29	34	15, 21, 23, 25, 27

[a] Only for structure 126 identified in Table 5 of Appendix B; detailed feasibility studies should be completed for other structures that meet FEMA simplified criteria to confirm an acceptable BCR
[b] Only for structures 126, 132, and 143 identified in Table 5 of Appendix B; detailed feasibility studies should be completed for other structures that meet FEMA simplified criteria to confirm an acceptable BCR
[c] Flood-related funding recommended only up to calculated value of benefits

Brief elaboration on the recommendations for the projects are provided below:

- **Priority 1: Relocation of Greene County Highway Garage**: As this structure is a critical community facility, use of this facility during and following a future flood event is of utmost importance to protect public safety and restore travel-ways. As such, not all the benefits this facility provides can be directly quantified. Complete relocation of this facility to a location outside of a Special Flood Hazard Area is recommended to eliminate the costs of future flood damage and maintain critical community functions during an emergency. WEC recommends that the Town apply for a CWC Sustainable Community Planning Grant to evaluate parcels that the facility could be relocated to. As part of this study, an improved cost estimate can be developed for the particular location and used to update the BCR of this alternative prior to advancing the project.

- **Priority 2: Fuel Tank Anchoring:** Anchoring of fuel tanks is an effective strategy that can be implemented in the short-term to reduce future flood damage for individual property owners and eliminate future potential water quality hazards. As funding is immediately available, WEC recommends that interested property owners within Zone A, Zone AE, or shaded Zone X flood hazard areas submit a Tank Anchoring Program Application to the CWC to fund the anchoring of currently-unanchored tanks.
- **Priority 3: Structure Elevation:** Elevation of structures was one of three alternatives in which a positive BCR was calculated. Structure elevations are recommended over acquisitions as structure elevations are generally more amenable to an individual property owner than acquisitions and also maintains the cohesion of the community. For structure number 126 identified Exhibit 5 of Appendix B, WEC recommends the Town engage the owner(s) of these properties to assess their willingness to elevate their house. For this property, the Town can act as the agent, on behalf of the property owner, for the application for project funding to the sources identified in Table 5-1. Prior to implementation of the elevation project, or if other property owners are interested in structure elevation, WEC recommends that a detailed feasibility study be completed, including an estimate of probable construction cost for elevation of the structure provided by a professional experienced in this type of work.
- **Priority 4: Structure Acquisition:** Acquisition of structures was one of three alternatives in which a BCR over 1.0 was calculated. For those structures recommended for acquisition, WEC recommends the Town engage the owners of these properties to assess their willingness to sell their house and relocate. The advantage of acquisition over elevation is that future flood costs would be entirely avoided. For those interested owners, the Town can act as the agent, on behalf of the property owner, for the application for project funding to the sources identified in Table 5-1. Prior to acquiring the property, or if other property owners express interest in acquisition, WEC recommends that a detailed feasibility study be completed for the specifics of that structures and its residents.
- **Priority 5: County Road 17 Floodplain Relief Culvert**: This alternative is recommended on the additional environmental benefits this alternative would provide at this heavy-utilized fishing site. As such, alternative funding for the environmental benefits of this project may be available from the sources identified in Table 5-1. However, WEC recommends funding of this alternative for flood mitigation purposes only up to the value of the calculated benefits presented in Table 4-9.

Although no major flood mitigation project had calculated benefits that exceeded its costs, it is WEC's opinion this is a positive outcome: many of the calculated benefits were small not because the projects were ineffective, but because there was little existing flood risk in the Town. This is proven by the relatively limited flood damage incurred as the result of Hurricane Irene and demonstrates that development in the Town of Ashland has been done responsibly. To the extent practical, existing practices of land use and zoning should be maintained in the future so as not to allow future development to increase the community's flood risk.

5.3 Flood Damage Reduction and Prevention Recommendations

In addition to the recommended flood mitigation projects, WEC considered input from the public, FAC, and Town Board, its professional experience, and limited review of the community's ordinances to recommend the following policies and minor projects that can be enacted on a shorter-time frame to reduce and prevent flood damage. These recommendations, and potential funding sources, are summarized in Table 5-2.

Table 5-2
Recommended Policies and Minor Projects to Reduce Flood Risk

Community-Level Recommendations	Funding Source
1. Maintain enrollment in FEMA's Community Rating System (CRS) and complete public information and floodplain management activities to obtain credits in the CRS that can be used to reduce flood risk and procure up to 45% discounts on flood insurance premiums	20, 22, 25
2. Adopt a Riparian Setback Ordinance to conserve existing, and promote new, healthy riparian corridors of mature, woody vegetation. The lack of mature, woody vegetation along the streambanks is a key contributor to streambank erosion hazards along the Batavia Kill.	22
3. Maintain existing land uses and development practices. In particular, agricultural or undeveloped lands generally have lower flood risk than developed properties and can more easily co-exist with flooding. Therefore, continued conservation of open space and cultivation of productive agricultural fields is recommended.	N/A
4. Possibly with the Towns of Prattsville and Windham, use the Corrected Effective Model to prepare a new hydraulic study of the Batavia Kill for establishment of revised Special Flood Hazard Areas. Preparation of a new hydraulic study is anticipated to reduce the size of the Special Flood Hazard Area and reduce base flood elevations, leading to decreased flood insurance premiums for local property owners. Revised Special Flood Hazard Areas can also better identify flood-prone properties and where future flood mitigation efforts are best focused.	5, 22, 25
5. If Recommendation 3 above is advanced, consider revising the local floodplain ordinance to manage development to the flood of record (Hurricane Irene). Structures and substantial improvements that are elevated above the flood of record will have a decreased flood risk in comparison to the standard Base Flood Elevation, leading to lower insurance premiums and future flood damages.	5, 22, 24
6. Create a Town account and train Town staff to use Greene County's Emergency Notification System to issue targeted alerts for pending flood hazards and other threatening situations.	20
7. Increase community awareness that driving across flooded roads is dangerous and should be avoided during a flood. Install flood warning signs along roadways subject to frequent flooding and develop alternate routes.	20

8. When inclement weather is expected, work with Greene County Highway Department to have a plan to relocate critical equipment out of the Special Flood Hazard Area when flooding is expected.	20
9. Revise the Town of Ashland's Building Permit Application to include and/or reference the requirements of the Flood Prevention Local Law and require approval of those construction activities identified in Article 1.2 of the Flood Prevention Local Law that occur in a Special Flood Hazard Area	22
10. Continue involvement in the Ulster County Multi-Jurisdictional Hazard Mitigation Plan; cross-identification of LFHMP-recommended projects in the MJHMP will increase chances for project funding. In addition, look for opportunities to participate in disaster-resiliency programs at the local, county, state, or Federal level. Examples of past opportunities include the New York Rising Community Reconstruction Program.	2, 20
11. Support USGS efforts to maintain and operate a stream gage on the Batavia Kill near the Town of Ashland to provide improved information to estimate the magnitude of rare floods.	25
12. Increase understanding of flood hazards by reaching out to the local community. Educate real estate agents and potential buyers on the location of Special Flood Hazard Areas in relation to structures for sale.	20, 25, 27
13. Following floods, collect, document and store information related to flood damage in the community. In particular, note the date, duration, and cause of flooding (tropical storm, snow-on-rain, etc.), survey high water marks within the Town, document the days a business is closed or a resident displaced, and document public and private flood recovery costs to support future mitigation planning efforts.	19, 25, 26
Property-Level Recommendations	**Funding Source**
1. Purchase flood insurance to insure your home, valuables, and family in event of future flood damage. In the event of flood damage, document the damage and retain all receipts. Work with the local emergency services coordinator to prepare and submit claims to FEMA.	26
2. Enroll in the Greene County Emergency Notification System (https://www.greenegovernment.com/departments/emergency-services/swift-911-registration) and New York Emergency Alerts System (https://alert.ny.gov/) to receive important real-time information and announcements, including flood hazard and severe weather notifications, from the County and State.	N/A
3. Store personal valuables at higher locations in your home to reduce the potential that these valuables are damaged in the event of a flood.	N/A

4. Remove household chemicals, fertilizers, gasoline, and potential contaminants that you do not anticipate using and dispose of at an approved facility. For those items that you anticipate using, store at higher locations in your home to reduce the potential that these contaminants enter downstream water supply during a flood event.	N/A
5. Store farm equipment, recreational vehicles, snowmobiles, and other motorized vehicles at high ground during periods of anticipated flood conditions to avoid damage to this equipment.	N/A
6. Plant appropriate, native plant species to establish healthy riparian corridors of mature, woody vegetation along streambanks to reduce the potential of future streambank erosion.	17, 23, 26, 27
7. Relocate flood-prone utilities to higher locations in your structure.	21, 25, 26
8. Install sewer backflow valves on sewer/septic outfalls to prevent back-flooding of your home.	21, 25, 26
9. Consider options to dry- or wet-floodproof your home. Section 5D and 5W of FEMA's *Engineering Principles and Practices for Retrofitting Flood-prone Residential Structures* provides additional details on available flood-proofing options and performance criteria	21, 25, 26

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Appendix A

Exhibits

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NOTES TO USERS

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National Geodetic Survey
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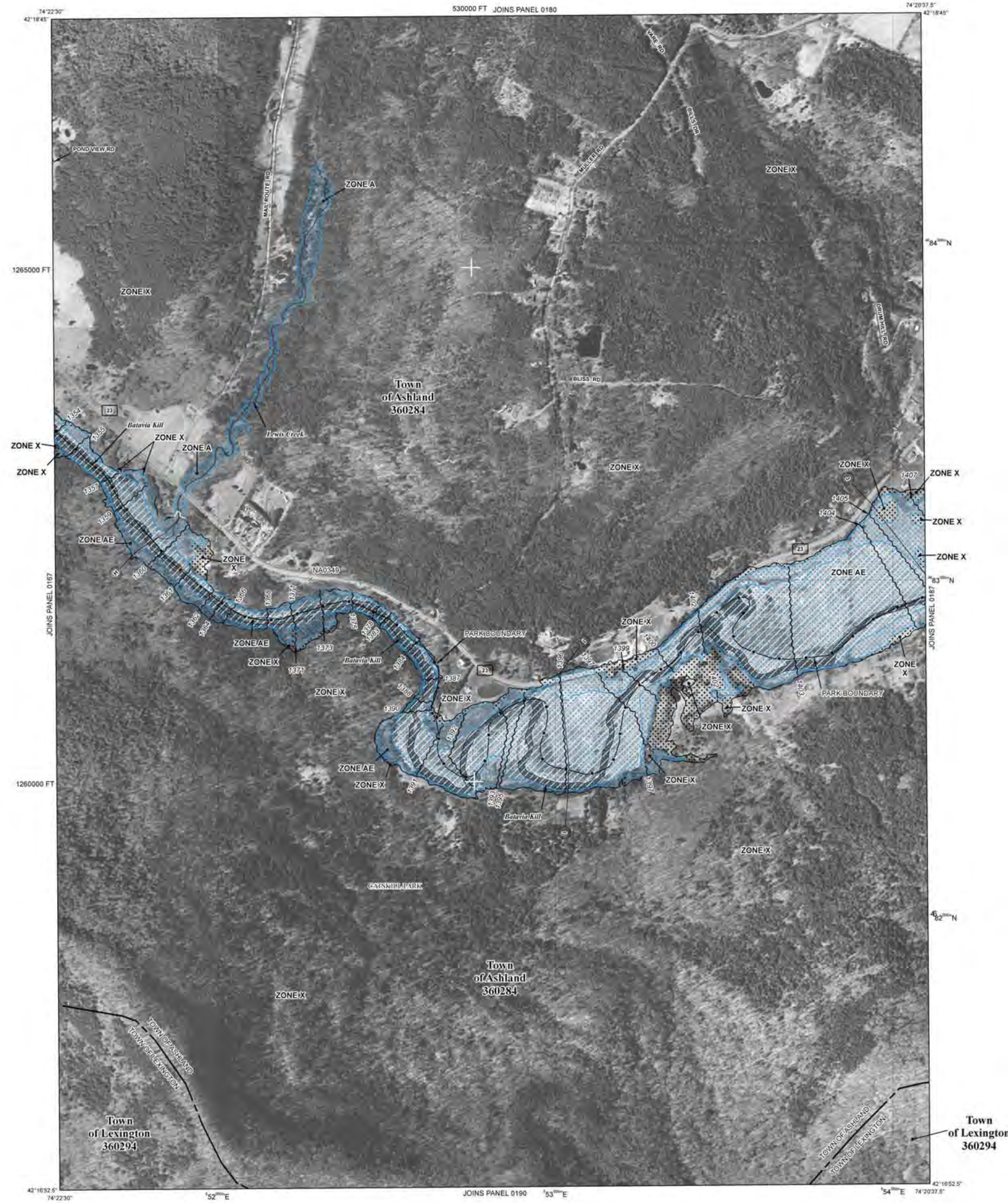

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	1% annual chance floodplain boundary
	0.2% annual chance floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)———(A)	Cross section line
[3]———[3]	Limited detail cross section line
(23)- - - -(23)	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
76N	1000-meter Universal Transverse Mercator grid values, zone NAD 1983 UTM Zone 18N
600000 FT	5000-foot grid ticks: New York State Plane coordinate system, central (FIPSZONE 3101), Transverse Mercator projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
MAY 16, 2008

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0186F

FIRM

FLOOD INSURANCE RATE MAP

for GREENE COUNTY, NEW YORK
ALL JURISDICTIONS

CONTAINS:

COMMUNITY	NUMBER
ASHLAND, TOWN OF	360284
LEXINGTON, TOWN OF	360294

PANEL 186 OF 531
MAP SUFFIX: F
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
36039C0186F

EFFECTIVE DATE
MAY 16, 2008

Federal Emergency Management Agency

Exhibit 1a. Flood Insurance Rate Maps

Local Flood Hazard Mitigation Plan
Town of Ashland
April 4, 2018

NOTES TO USERS

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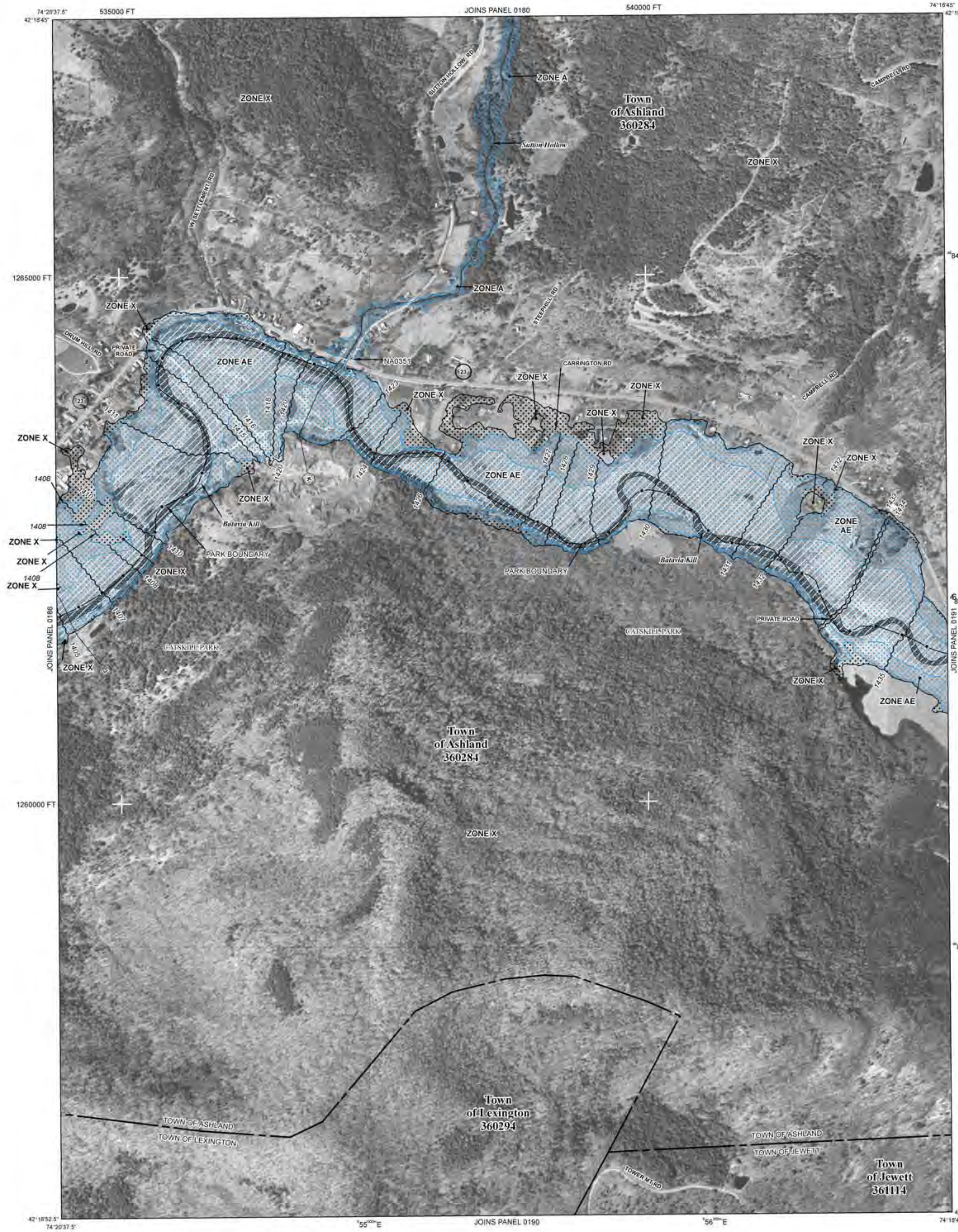
Exhibit 1b. Flood Insurance Rate Maps

Local Flood Hazard Mitigation Plan
Town of Ashland
April 4, 2018



LEGEND

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ZONE A	No Base Flood Elevations determined.
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FLOODWAY AREAS IN ZONE AE

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OTHER FLOOD AREAS

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NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0187F

FIRM
FLOOD INSURANCE RATE MAP

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ALL JURISDICTIONS

CONTAINS:

COMMUNITY	NUMBER
ASHLAND, TOWN OF	360284
JEWETT, TOWN OF	361114
LEXINGTON, TOWN OF	360294

PANEL 187 OF 531
MAP SUFFIX: F
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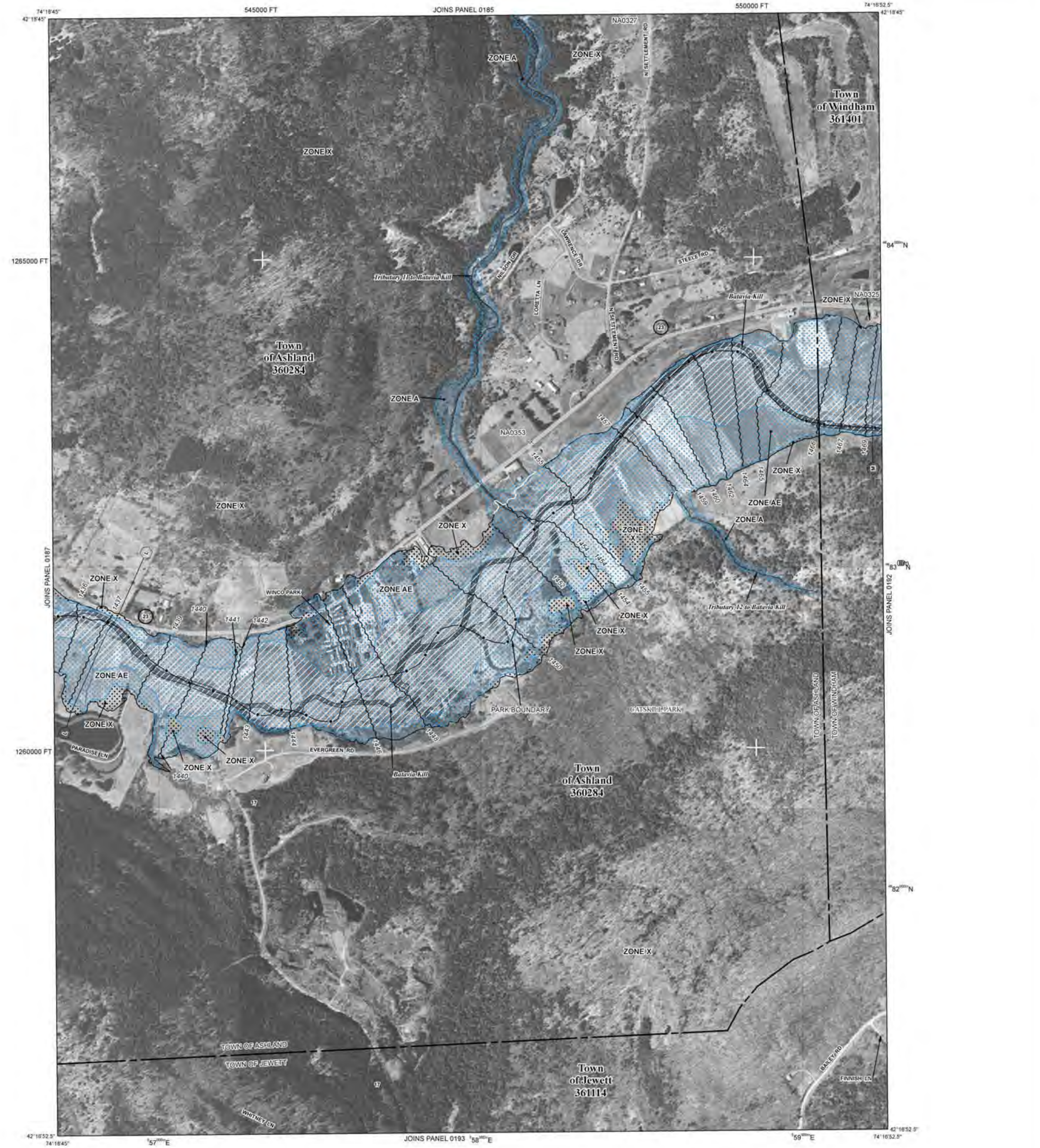

LEGEND

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- **ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- **ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

- **ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- **ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- **ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- ~~~ 513 ~~~ Base Flood Elevation line and value; elevation in feet*
- (EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

- (A)——(A) Cross section line
- [3]——[3] Limited detail cross section line
- (23)- - - -(23) Transect line
- 87°07'45", 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
- 76 N 1000-meter Universal Transverse Mercator grid values, zone NAD 1983 UTM Zone 18N
- 600000 FT 5000-foot grid ticks: New York State Plane coordinate system, central (FIPSZONE 3101), Transverse Mercator projection
- DX5510 x Bench mark (see explanation in Notes to Users section of this FIRM panel)
- • M1.5 River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
MAY 16, 2008

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0191F

FIRM

FLOOD INSURANCE RATE MAP

for GREENE COUNTY, NEW YORK
ALL JURISDICTIONS

CONTAINS:

COMMUNITY	NUMBER
ASHLAND, TOWN OF	360284
JEWETT, TOWN OF	361114
WINDHAM, TOWN OF	361401

PANEL 191 OF 531
MAP SUFFIX: F
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
36039C0191F

EFFECTIVE DATE
MAY 16, 2008

Federal Emergency Management Agency

Exhibit 1c. Flood Insurance Rate Maps

Local Flood Hazard Mitigation Plan
Town of Ashland
April 4, 2018

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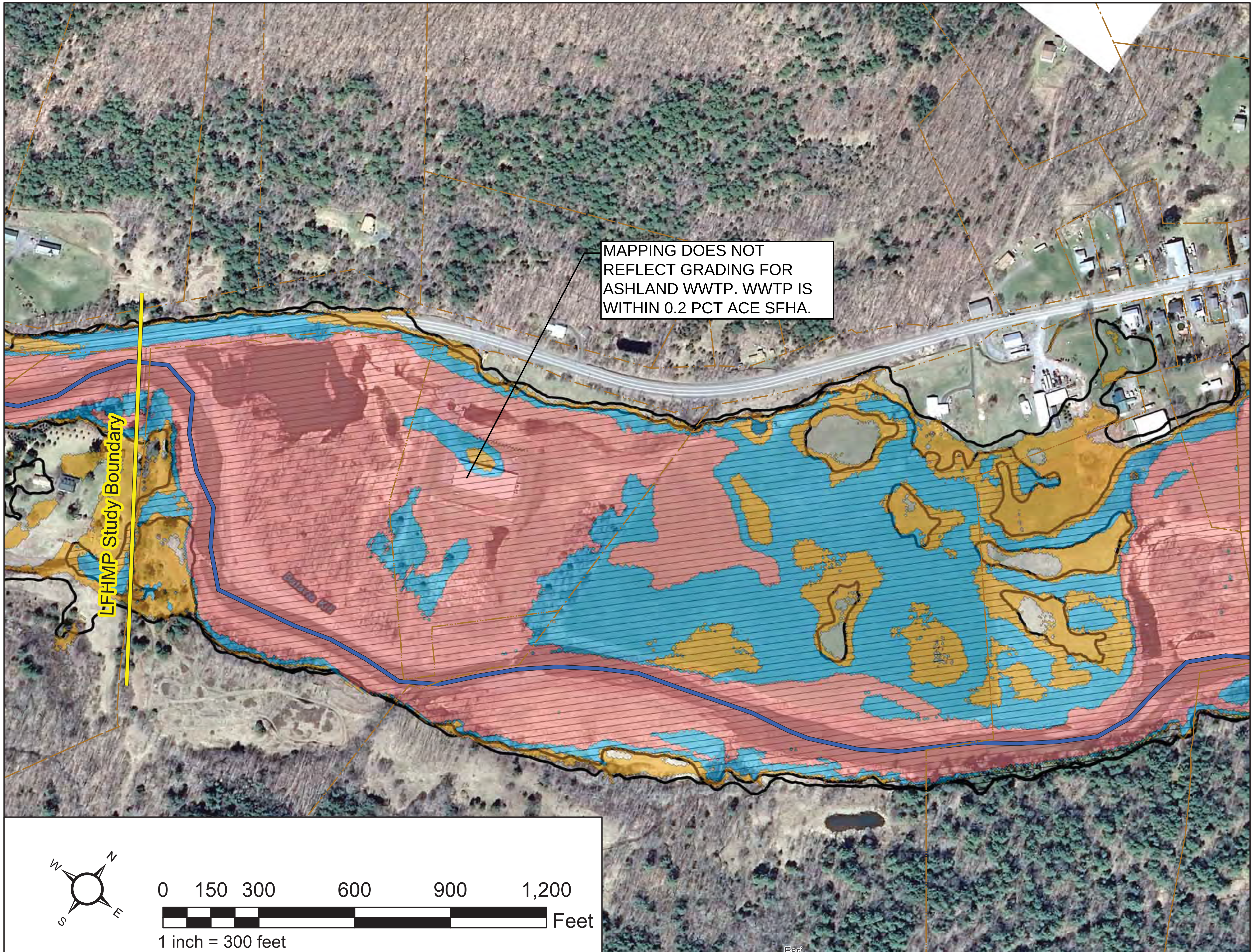

EXHIBIT 2a CORRECTED EFFECTIVE FLOODPLAIN MAPPING

Legend

Tax Parcels

Batavia Kill Centerline

Corrected Effective Model

10pct ACE (10yr)

1.0pct ACE (100yr)

0.2pct ACE (500yr)

Effective FEMA SFHA

1.0pct ACE (100yr)

1.0pct ACE (100yr)

0.2pct ACE (500yr)

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PREPARED BY:

Woidt Engineering

Woidt Engineering & Consulting, P.C.
11 South Washington Street
Binghamton, New York 13903
www.woidtengineering.com

PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland
April 4, 2018

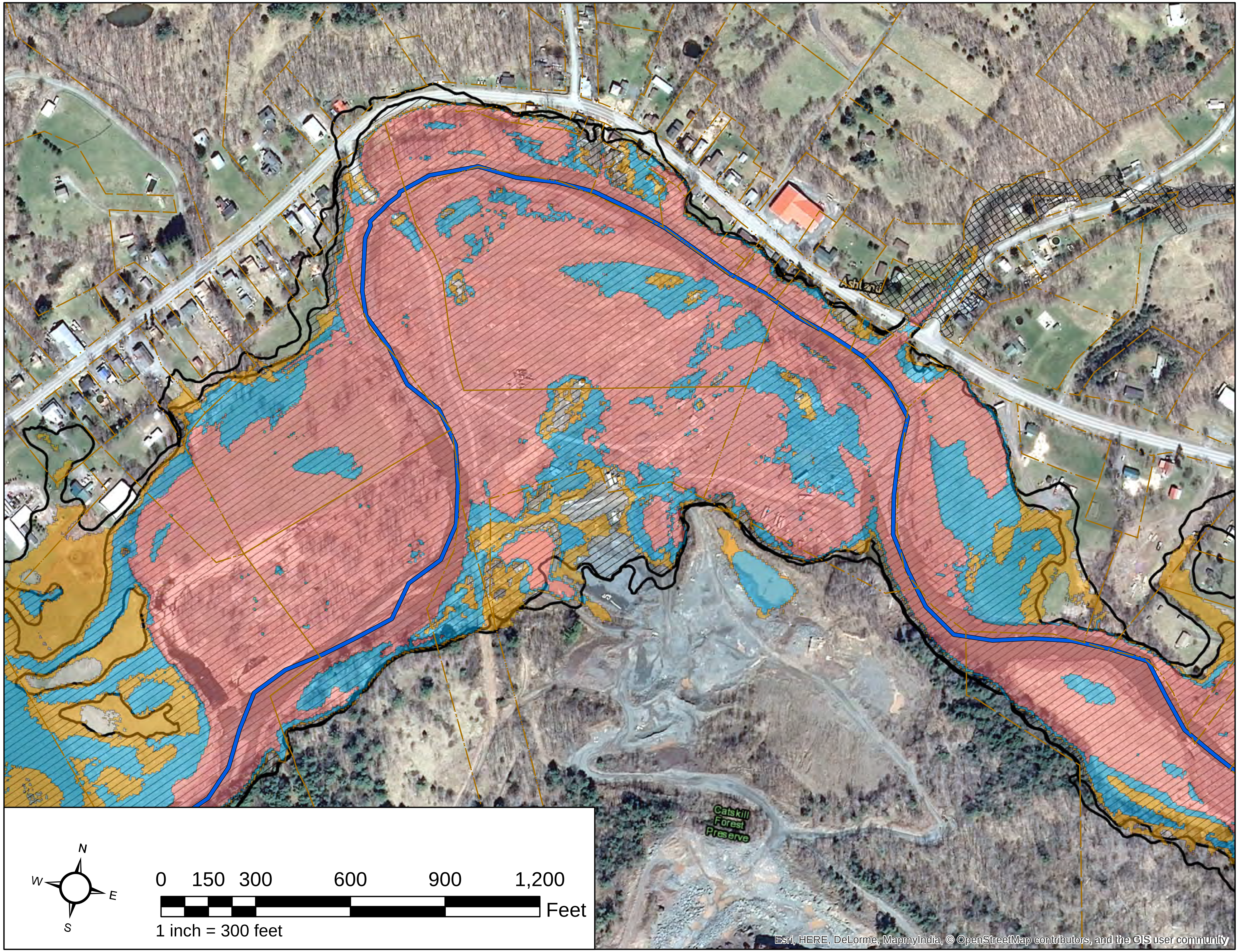

EXHIBIT 2b CORRECTED EFFECTIVE FLOODPLAIN MAPPING

Legend

Tax Parcels

Batavia Kill Centerline

Corrected Effective Model

10pct ACE (10yr)

1.0pct ACE (100yr)

0.2pct ACE (500yr)

Effective FEMA SFHA

1.0pct ACE (100yr)

1.0pct ACE (100yr)

0.2pct ACE (500yr)

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Binghamton, New York 13903
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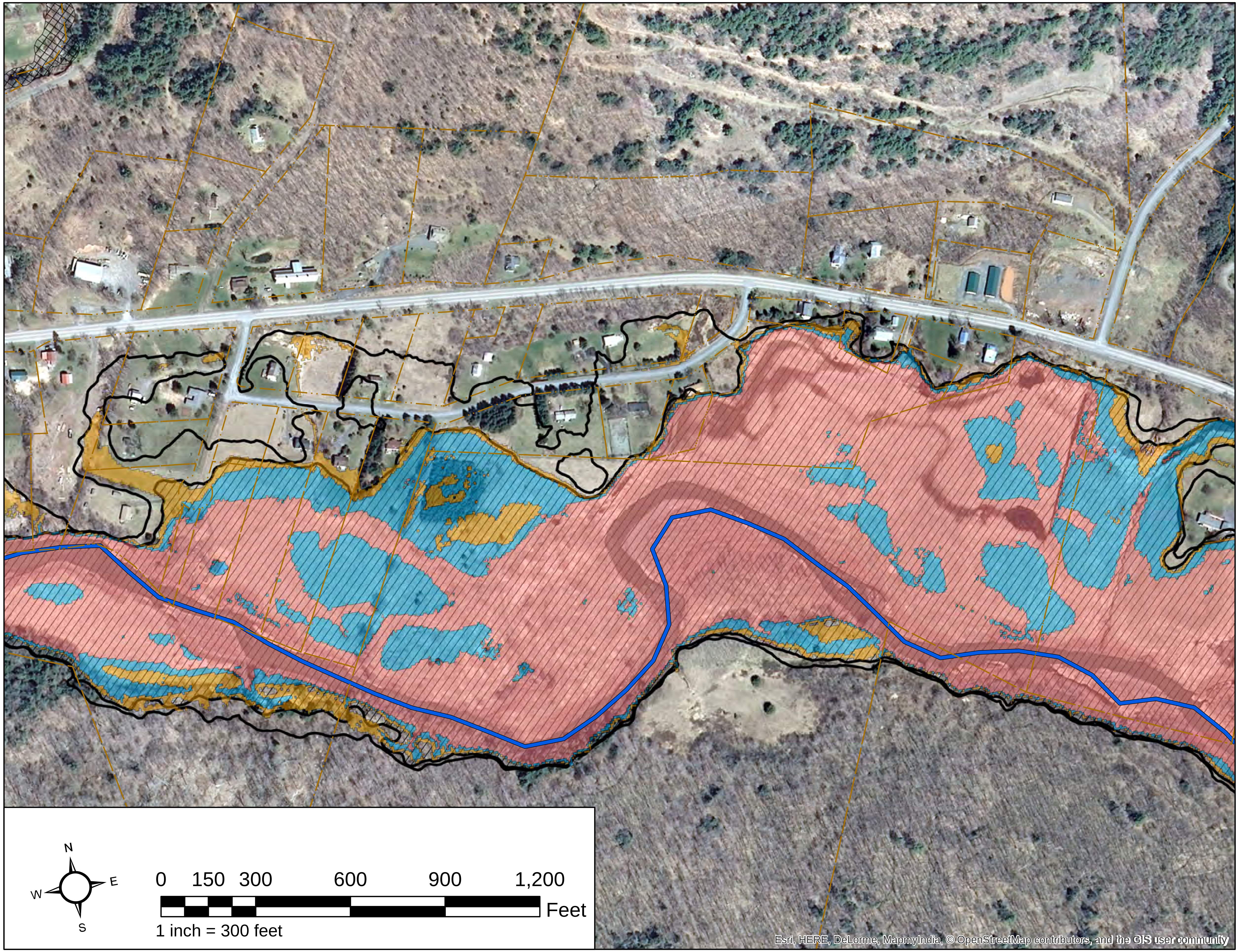
PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland
April 4, 2018



Legend

Tax Parcels

Batavia Kill Centerline

Corrected Effective Model

10pct ACE (10yr)

1.0pct ACE (100yr)

0.2pct ACE (500yr)

Effective FEMA SFHA

1.0pct ACE (100yr)

1.0pct ACE (100yr)

0.2pct ACE (500yr)

PREPARED FOR:

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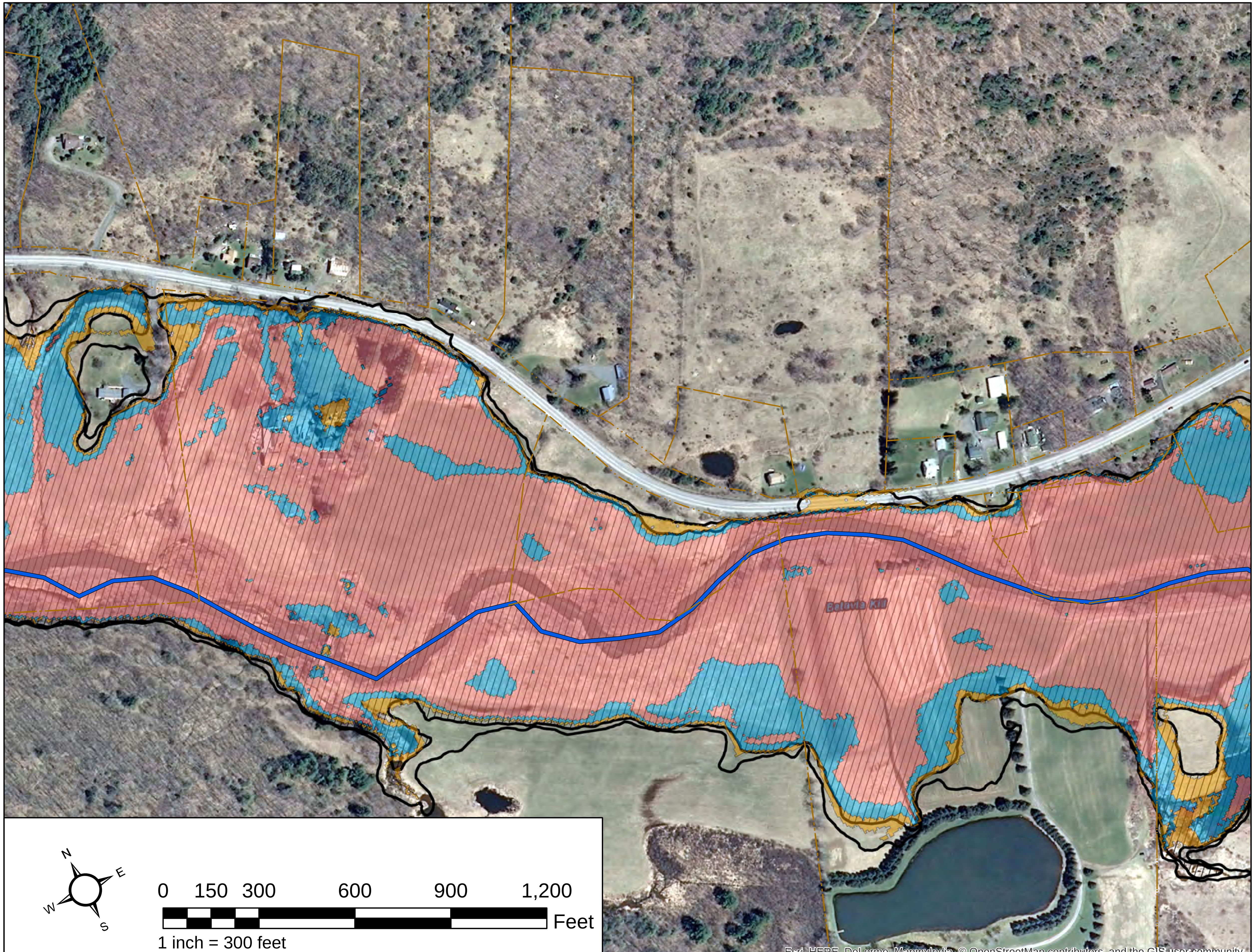
PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland
April 4, 2018

EXHIBIT 2c CORRECTED EFFECTIVE FLOODPLAIN MAPPING



Legend

Tax Parcels

Batavia Kill Centerline

Corrected Effective Model

10pct ACE (10yr)

1.0pct ACE (100yr)

0.2pct ACE (500yr)

Effective FEMA SFHA

1.0pct ACE (100yr)

1.0pct ACE (100yr)

0.2pct ACE (500yr)

PREPARED FOR:

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PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland
April 4, 2018

EXHIBIT 2d CORRECTED EFFECTIVE FLOODPLAIN MAPPING

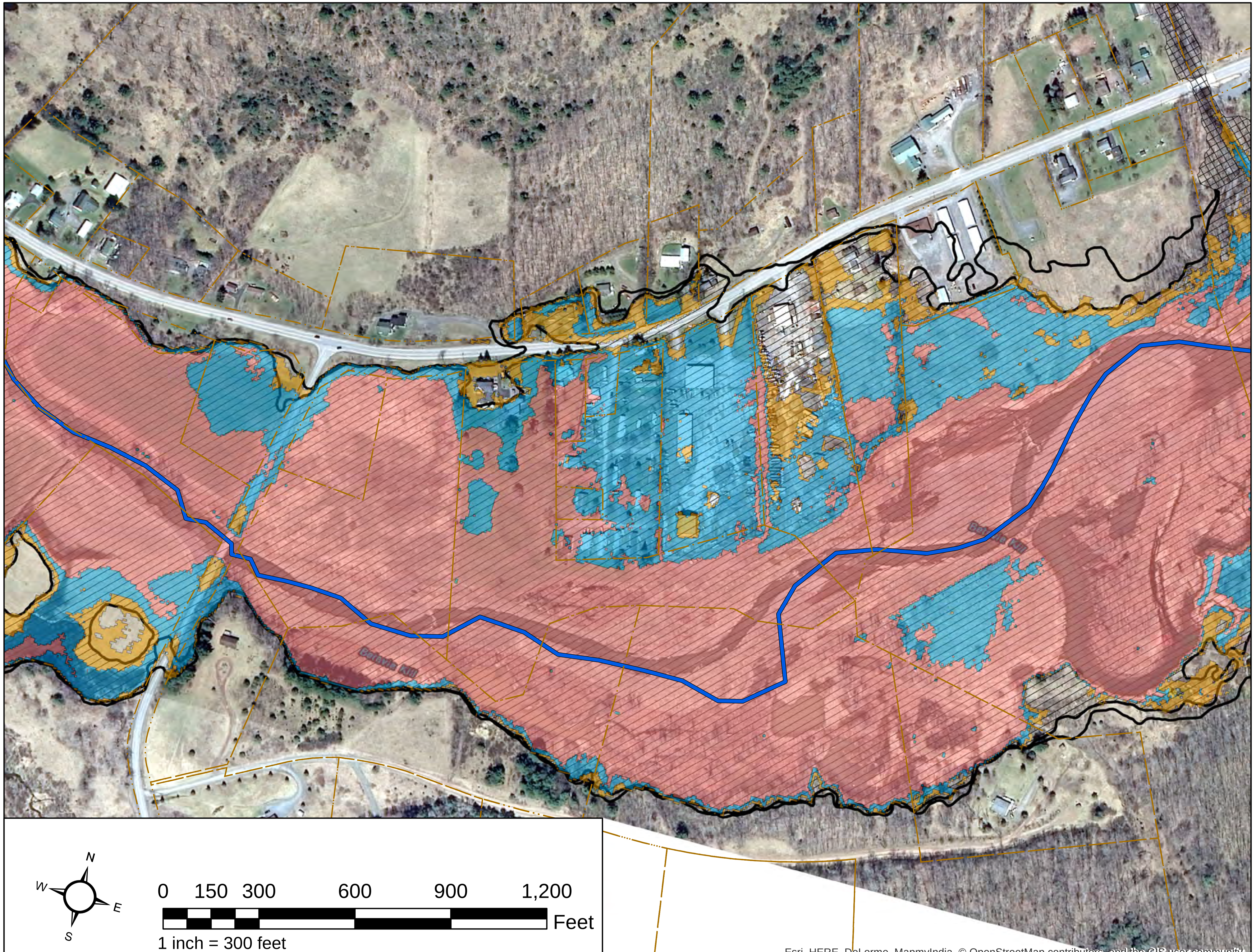

EXHIBIT 2e CORRECTED EFFECTIVE FLOODPLAIN MAPPING

Legend

- Tax Parcels
- Batavia Kill Centerline

Corrected Effective Model

- 10pct ACE (10yr)
- 1.0pct ACE (100yr)
- 0.2pct ACE (500yr)

Effective FEMA SFHA

- 1.0pct ACE (100yr)
- 1.0pct ACE (100yr)
- 0.2pct ACE (500yr)

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PREPARED BY:

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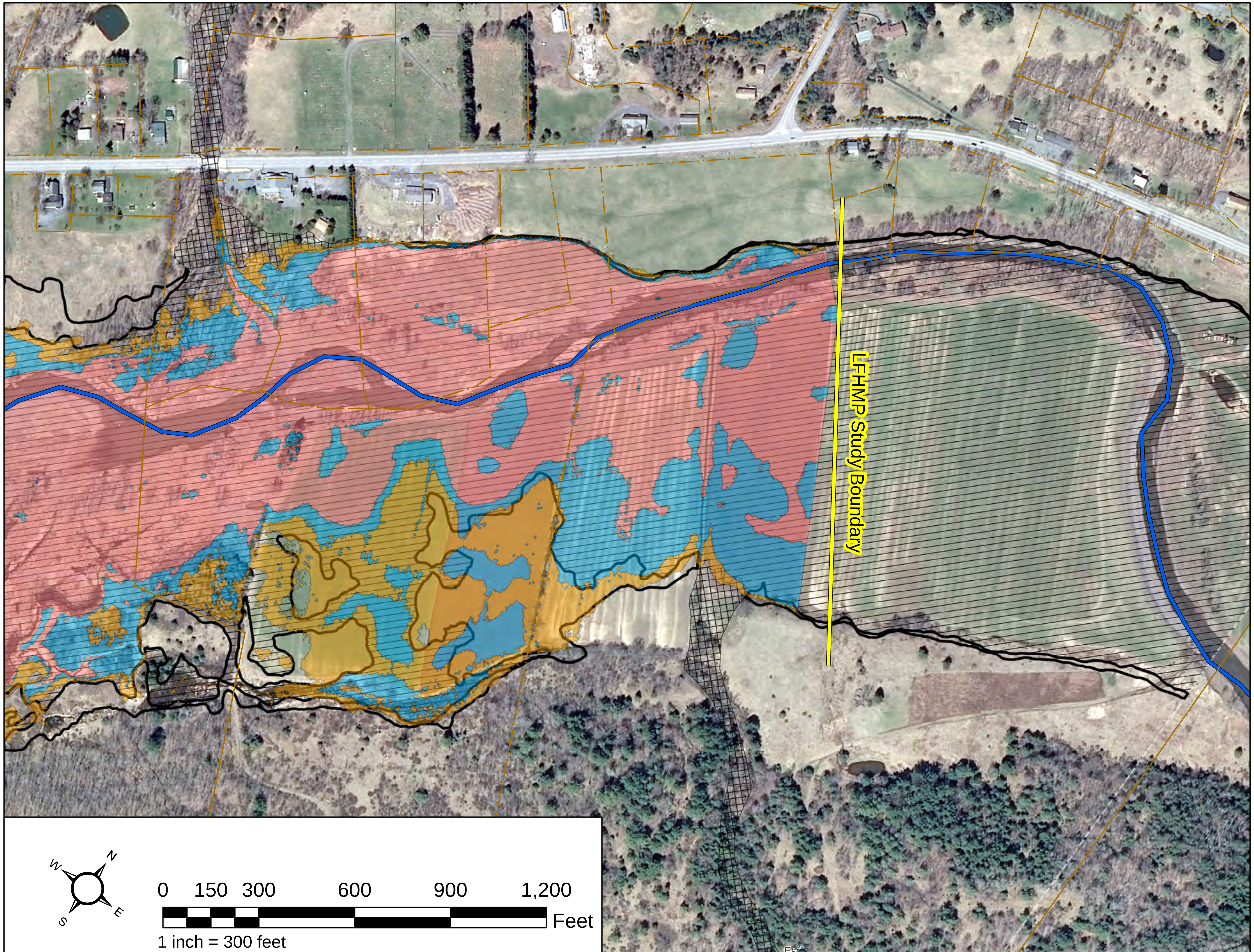
PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland
April 4, 2018



Legend

- Tax Parcels
- Batavia Kill Centerline

Corrected Effective Model

- 10pct ACE (10yr)
- 1.0pct ACE (100yr)
- 0.2pct ACE (500yr)

Effective FEMA SFHA

- 1.0pct ACE (100yr)
- 1.0pct ACE (100yr)
- 0.2pct ACE (500yr)

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PREPARED BY:

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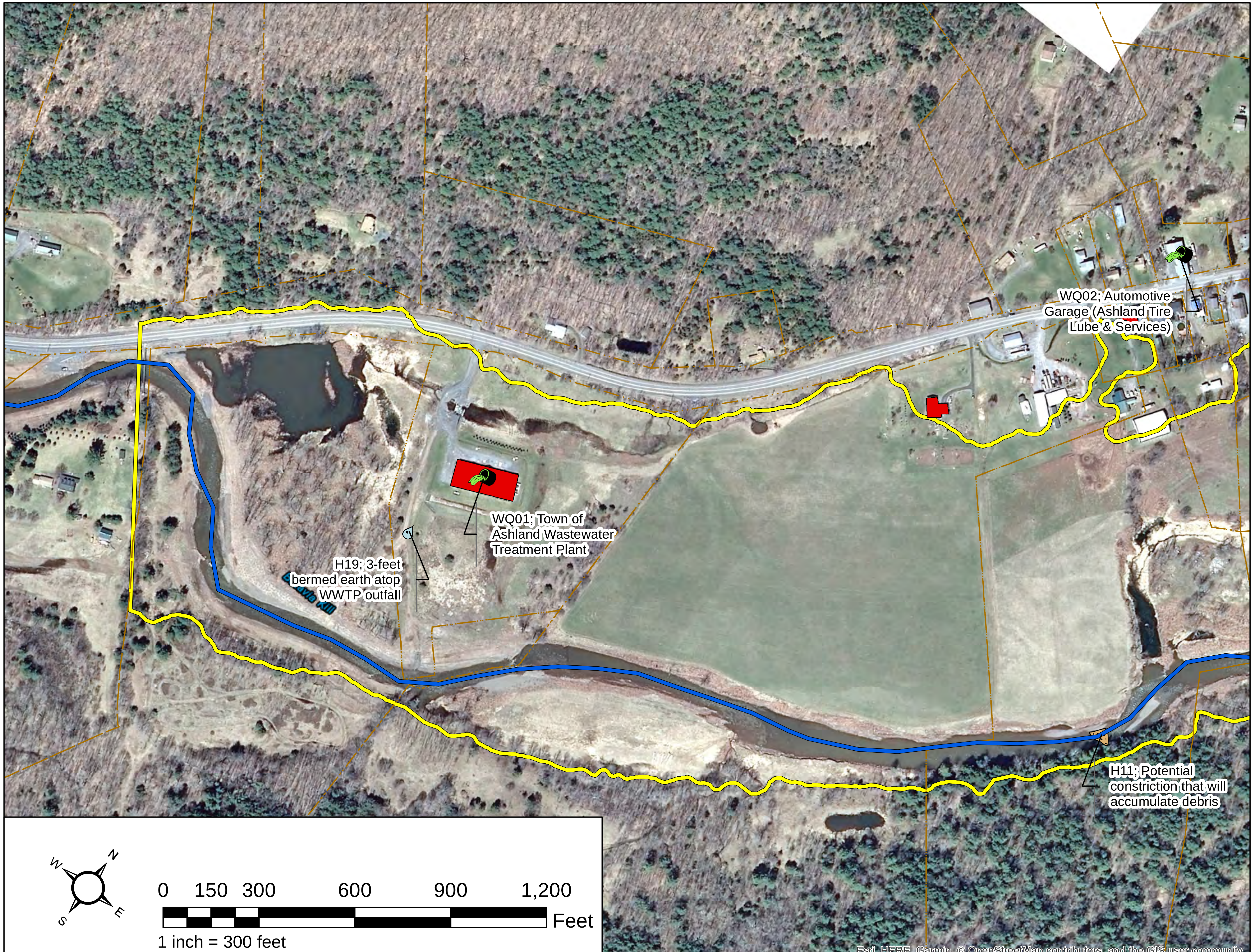
PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland
April 4, 2018

EXHIBIT 2f CORRECTED EFFECTIVE FLOODPLAIN MAPPING



Legend

- Batavia Kill Centerline
- Tax Parcels
- LFHMP Study Area
- Flood-prone Properties

Potential Flood Hazards

- Debris
- Erosion
- Infrastructure
- Riverine
- Water Quality

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PREPARED BY:

Woidt Engineering & Consulting, P.C.
11 South Washington Street
Binghamton, New York 13903
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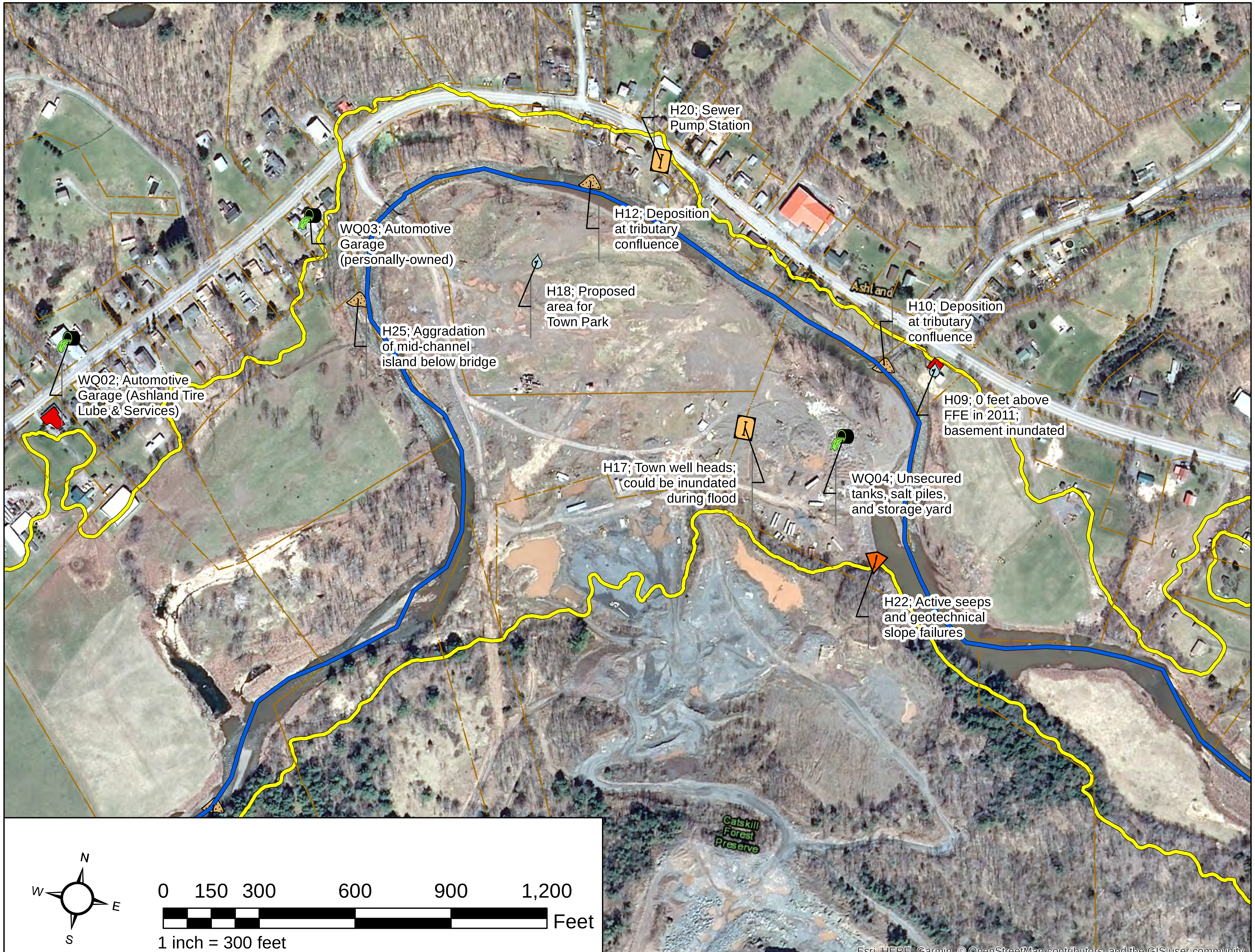
PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland
August 16, 2018

EXHIBIT 3a FLOOD HAZARDS AND FLOOD-PRONE PROPERTIES



Legend

- Batavia Kill Centerline
- Tax Parcels
- LFHMP Study Area
- Flood-prone Properties

Potential Flood Hazards

- Debris
- Erosion
- Infrastructure
- Riverine
- Water Quality

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PREPARED BY:

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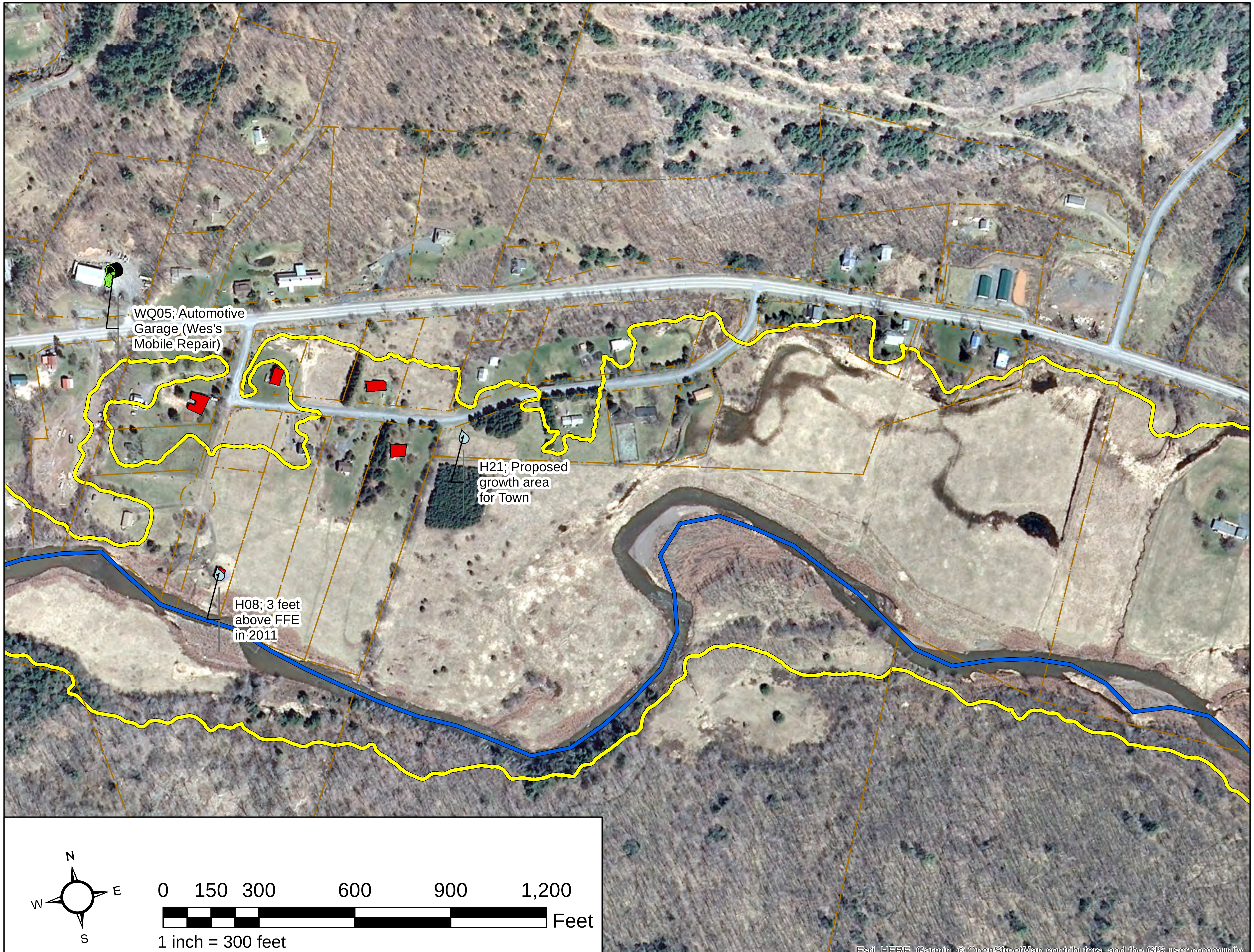
PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland
August 16, 2018

EXHIBIT 3b FLOOD HAZARDS AND FLOOD-PRONE PROPERTIES



Legend

- Batavia Kill Centerline
- Tax Parcels
- LFHMP Study Area
- Flood-prone Properties

Potential Flood Hazards

- Debris
- Erosion
- Infrastructure
- Riverine
- Water Quality

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

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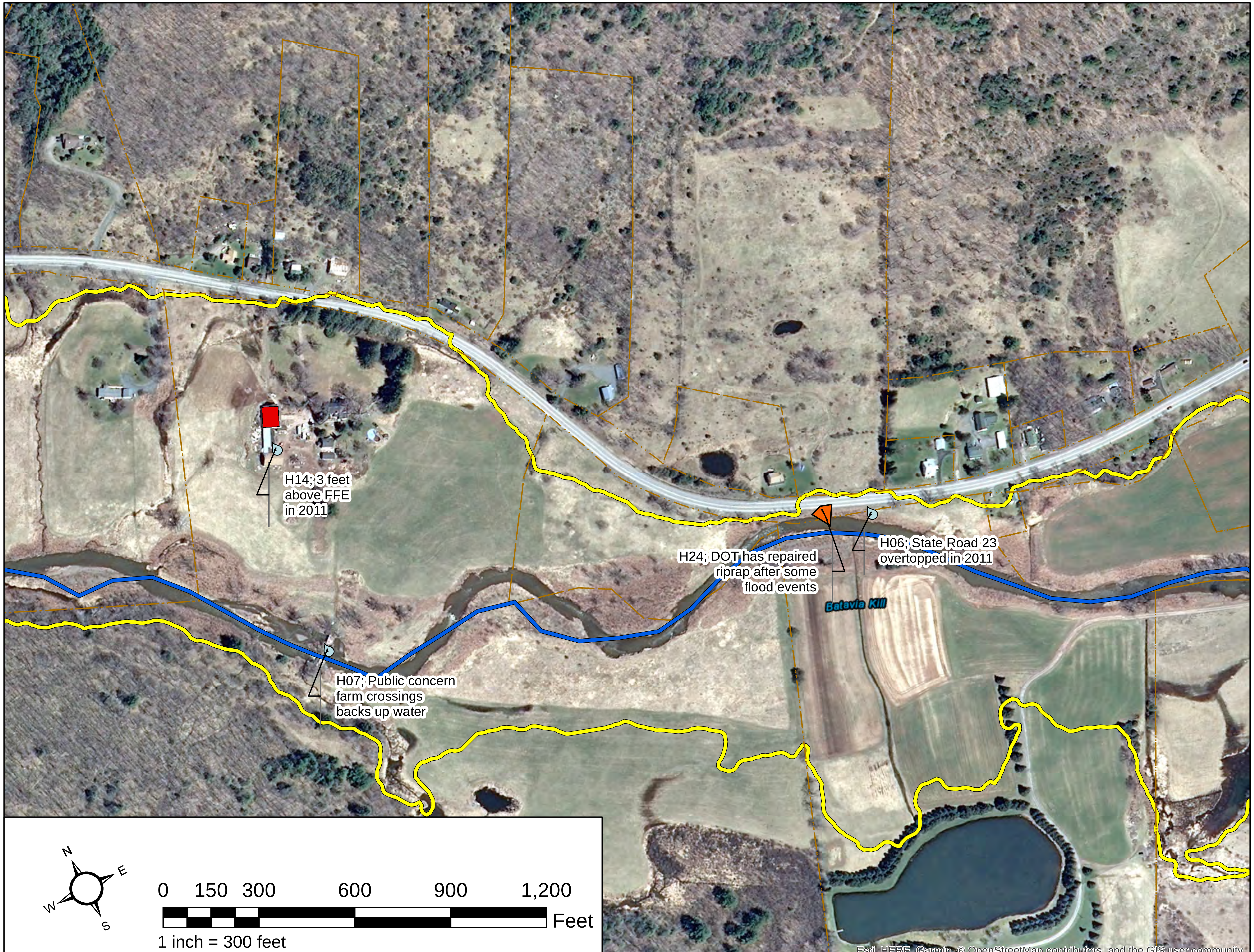
PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland
August 16, 2018

EXHIBIT 3c FLOOD HAZARDS AND FLOOD-PRONE PROPERTIES



Legend

- Batavia Kill Centerline
- Tax Parcels
- LFHMP Study Area
- Flood-prone Properties

Potential Flood Hazards

- Debris
- Erosion
- Infrastructure
- Riverine
- Water Quality

PREPARED FOR:

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PREPARED BY:

Woidt Engineering

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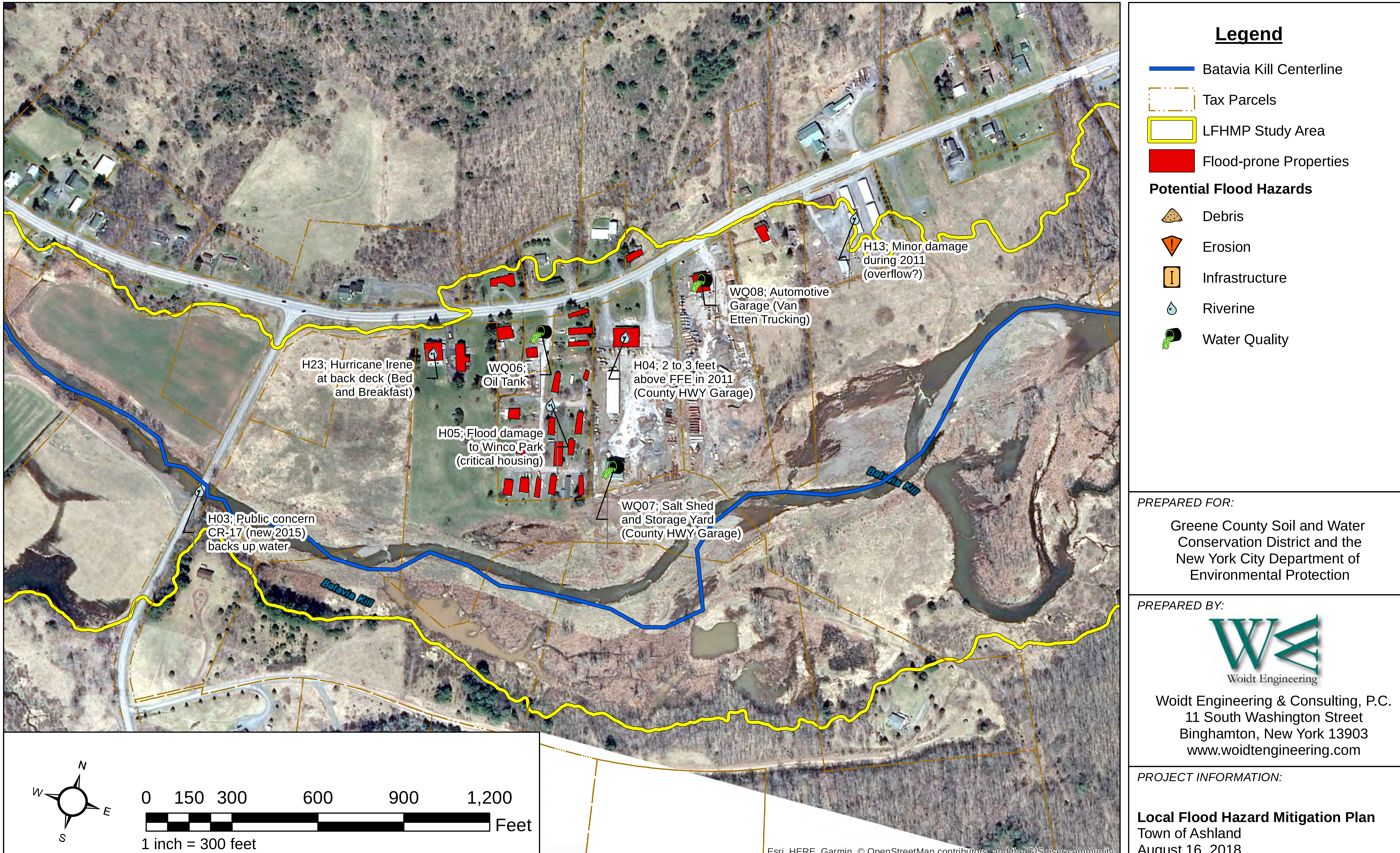
PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland
August 16, 2018

EXHIBIT 3d FLOOD HAZARDS AND FLOOD-PRONE PROPERTIES



PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

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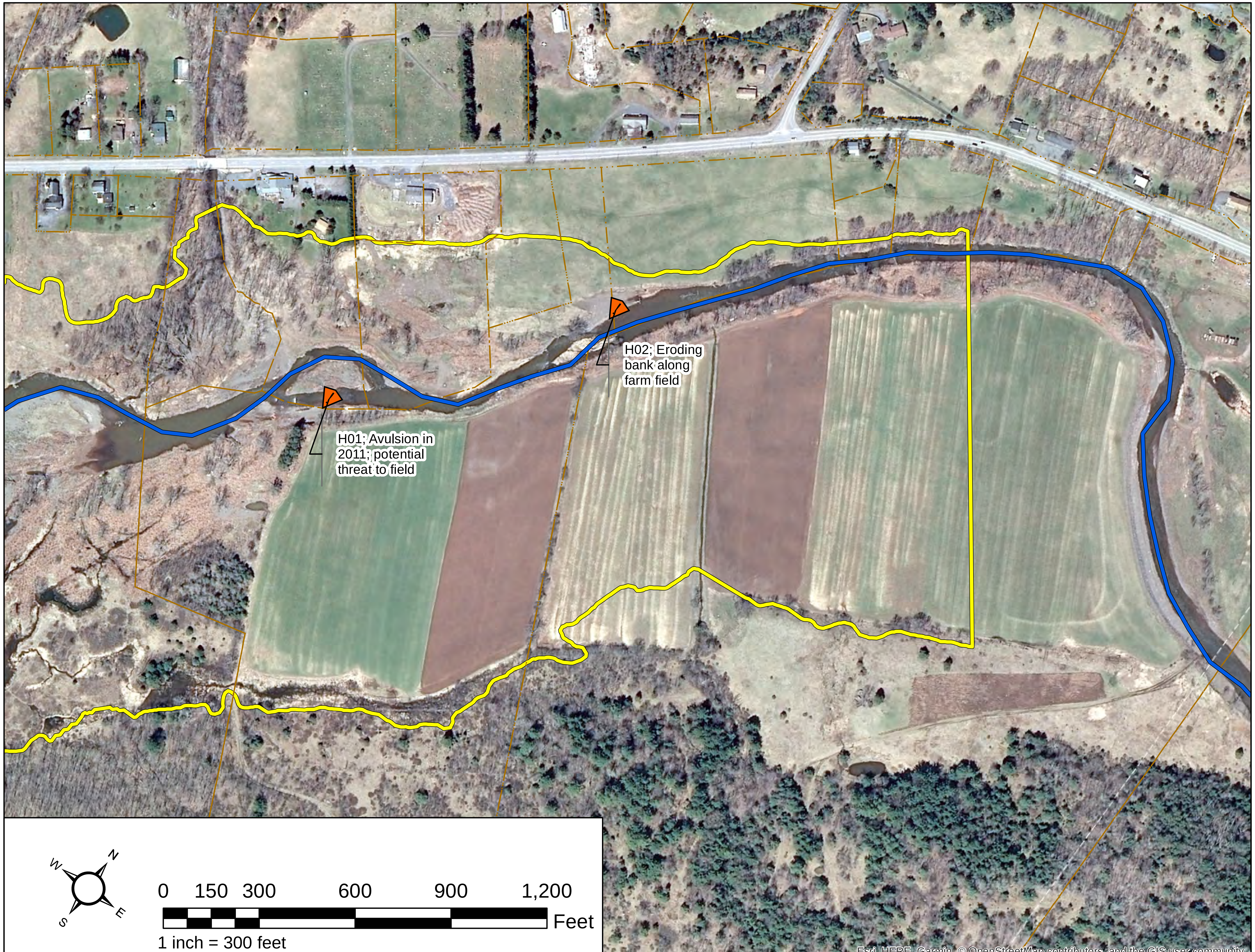
PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland
August 16, 2018

EXHIBIT 3e FLOOD HAZARDS AND FLOOD-PRONE PROPERTIES



Legend

- Batavia Kill Centerline
- Tax Parcels
- LFHMP Study Area
- Flood-prone Properties

Potential Flood Hazards

- Debris
- Erosion
- Infrastructure
- Riverine
- Water Quality

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PREPARED BY:

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PROJECT INFORMATION:

Local Flood Hazard Mitigation Plan
Town of Ashland
August 16, 2018

EXHIBIT 3f FLOOD HAZARDS AND FLOOD-PRONE PROPERTIES

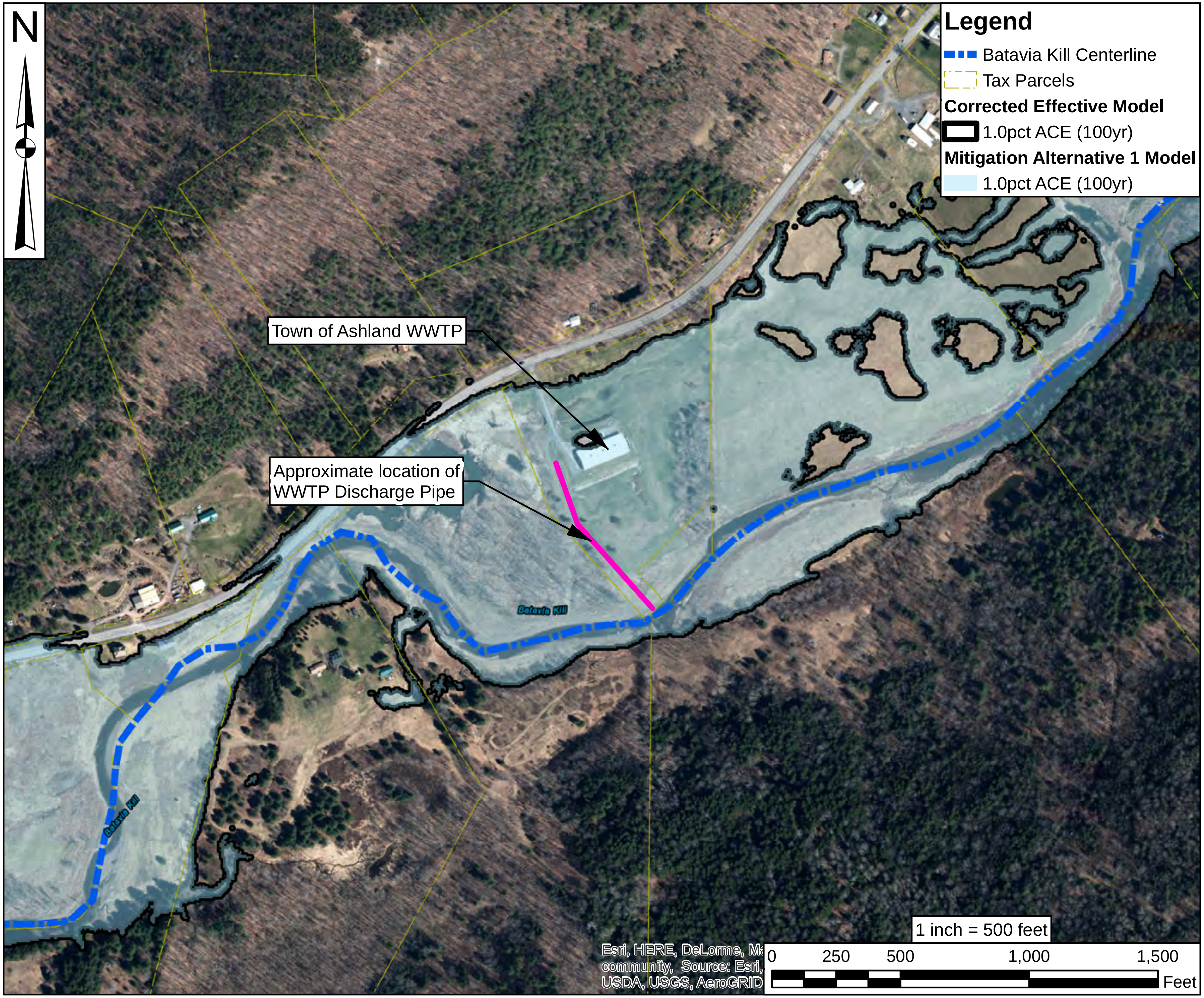

EXHIBIT 4a MODIFICATION OF WWTP DISCHARGE PIPE

PREPARED BY:

Woidt Engineering & Consulting, P.C.
11 South Washington Street
Binghamton, New York 13903
www.woidtengineering.com

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PROJECT INFORMATION:

Local Flood Hazard Mitigation Project
Preliminary Flood Mitigation Alternatives
AUGUST 17th, 2018

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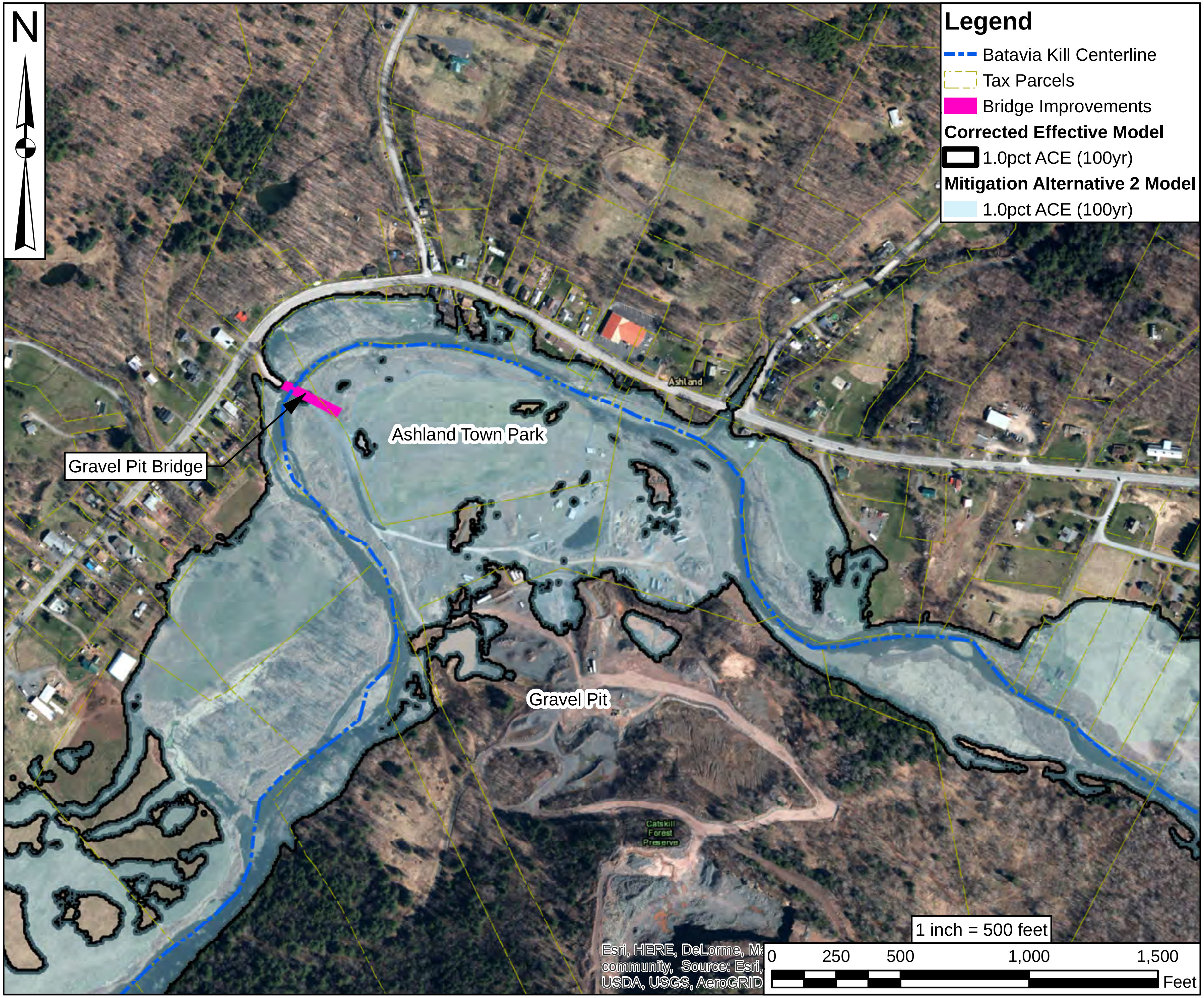

EXHIBIT 4b Gravel Pit Bridge Improvement

PREPARED BY:

Woidt Engineering & Consulting, P.C.
11 South Washington Street
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Woidt Engineering

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PROJECT INFORMATION:

Local Flood Hazard Mitigation Project
Preliminary Flood Mitigation Alternatives
AUGUST 17th, 2018

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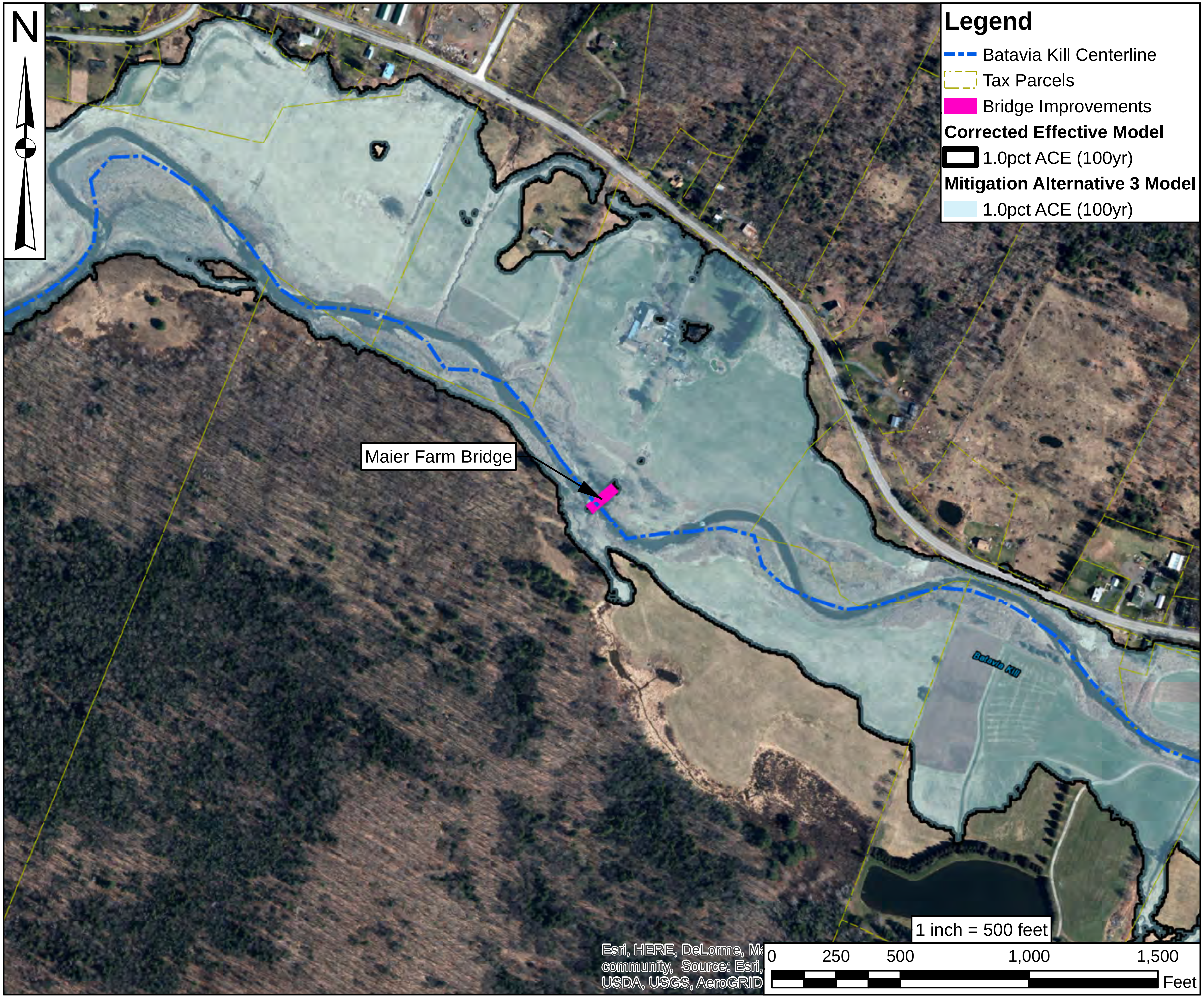

EXHIBIT 4c Maier Farm Bridge Improvement

PREPARED BY:

Woidt Engineering & Consulting, P.C.
11 South Washington Street
Binghamton, New York 13903
www.woidtengineering.com

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PROJECT INFORMATION:

Local Flood Hazard Mitigation Project
Preliminary Flood Mitigation Alternatives
AUGUST 17th, 2018

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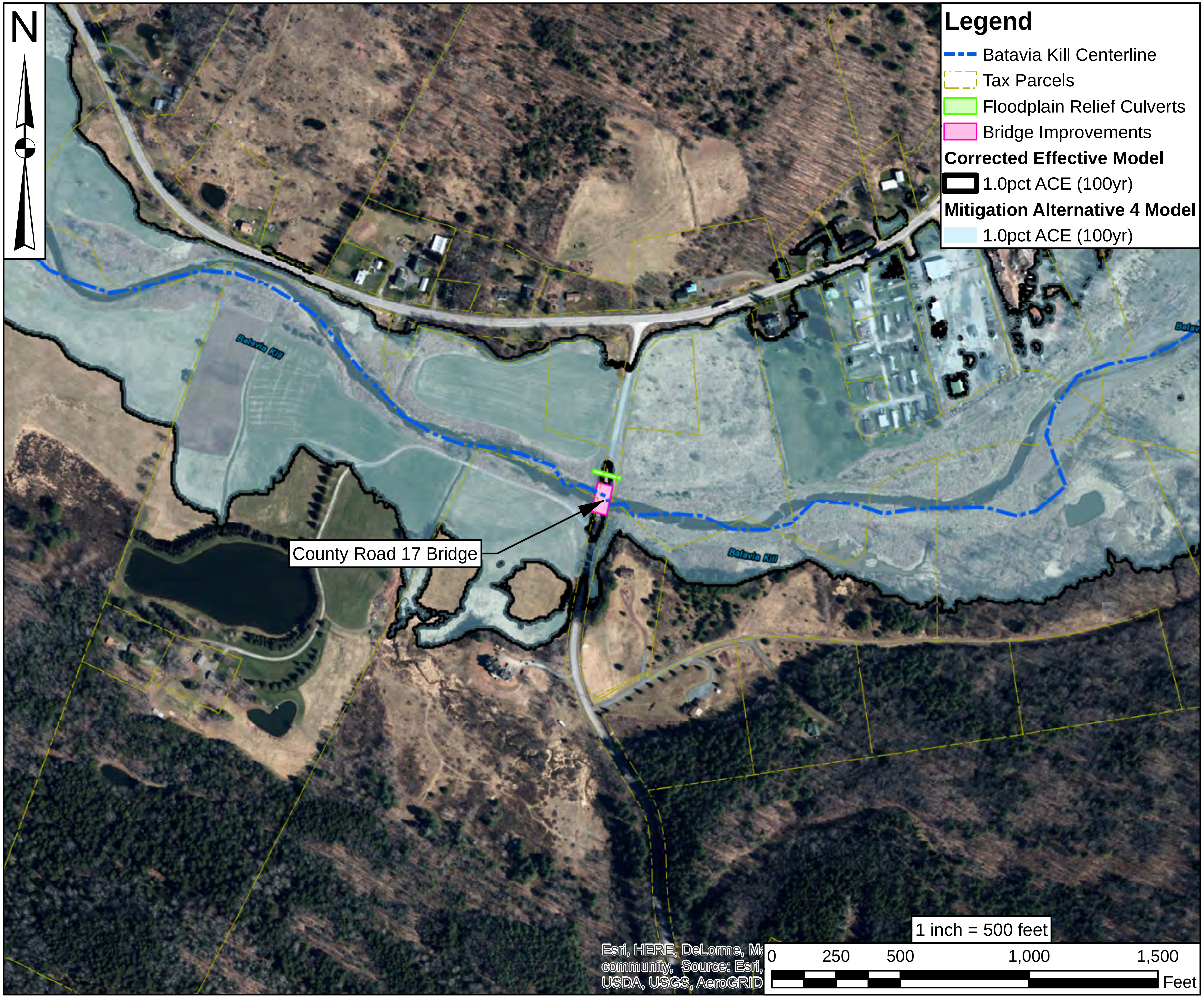


EXHIBIT 4d County Road 17 Floodplain Relief Culverts

PREPARED BY:

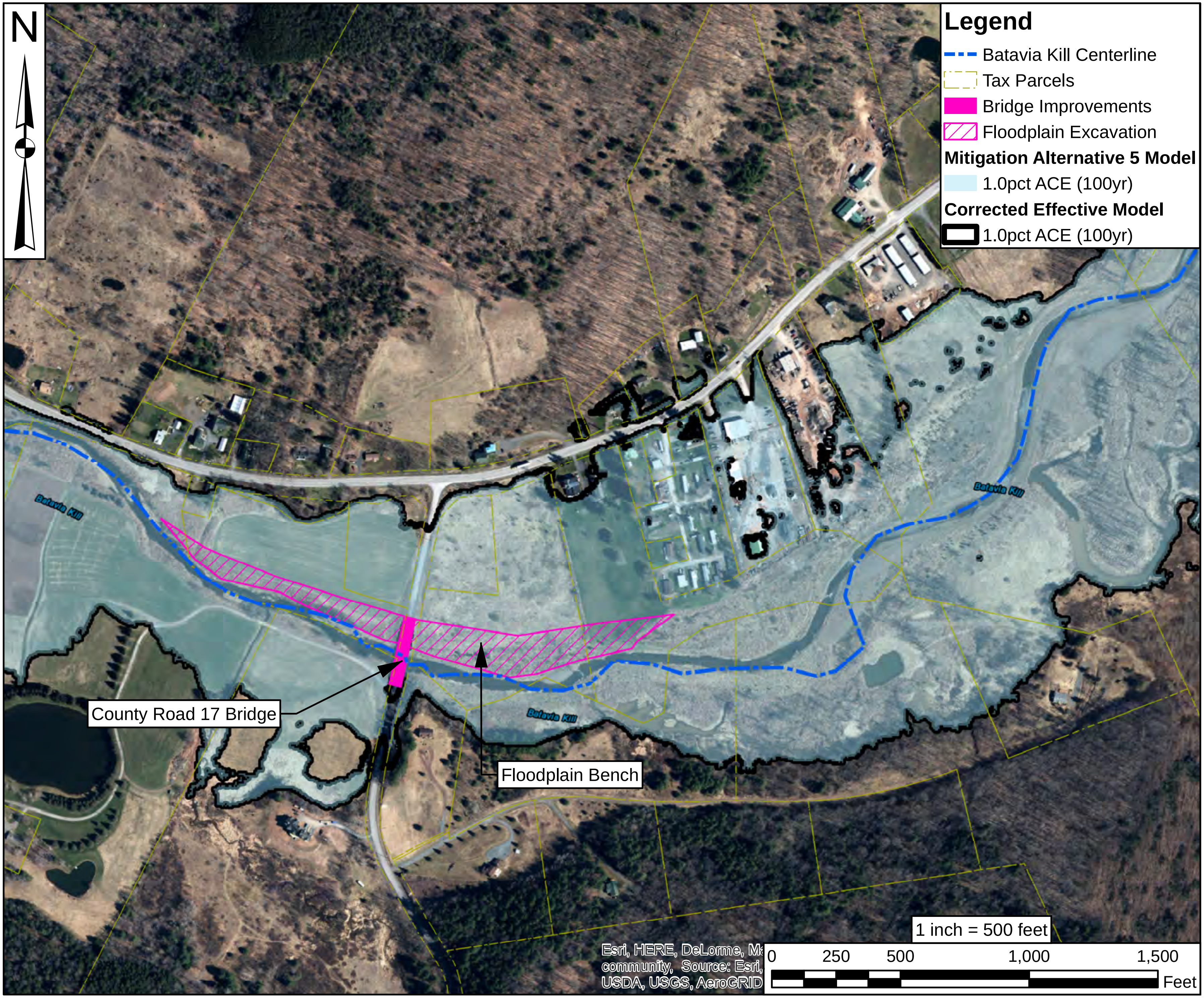
Woidt Engineering & Consulting, P.C.
11 South Washington Street
Binghamton, New York 13903
www.woidtengineering.com

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PROJECT INFORMATION:

Local Flood Hazard Mitigation Project
Preliminary Flood Mitigation Alternatives
AUGUST 17th, 2018



PREPARED BY:

Woidt Engineering & Consulting, P.C.
11 South Washington Street
Binghamton, New York 13903
www.woidtengineering.com

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PROJECT INFORMATION:

Local Flood Hazard Mitigation Project
Preliminary Flood Mitigation Alternatives
AUGUST 17th, 2018

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EXHIBIT 4e County Road 17 Bridge Widening & Floodplain Bench

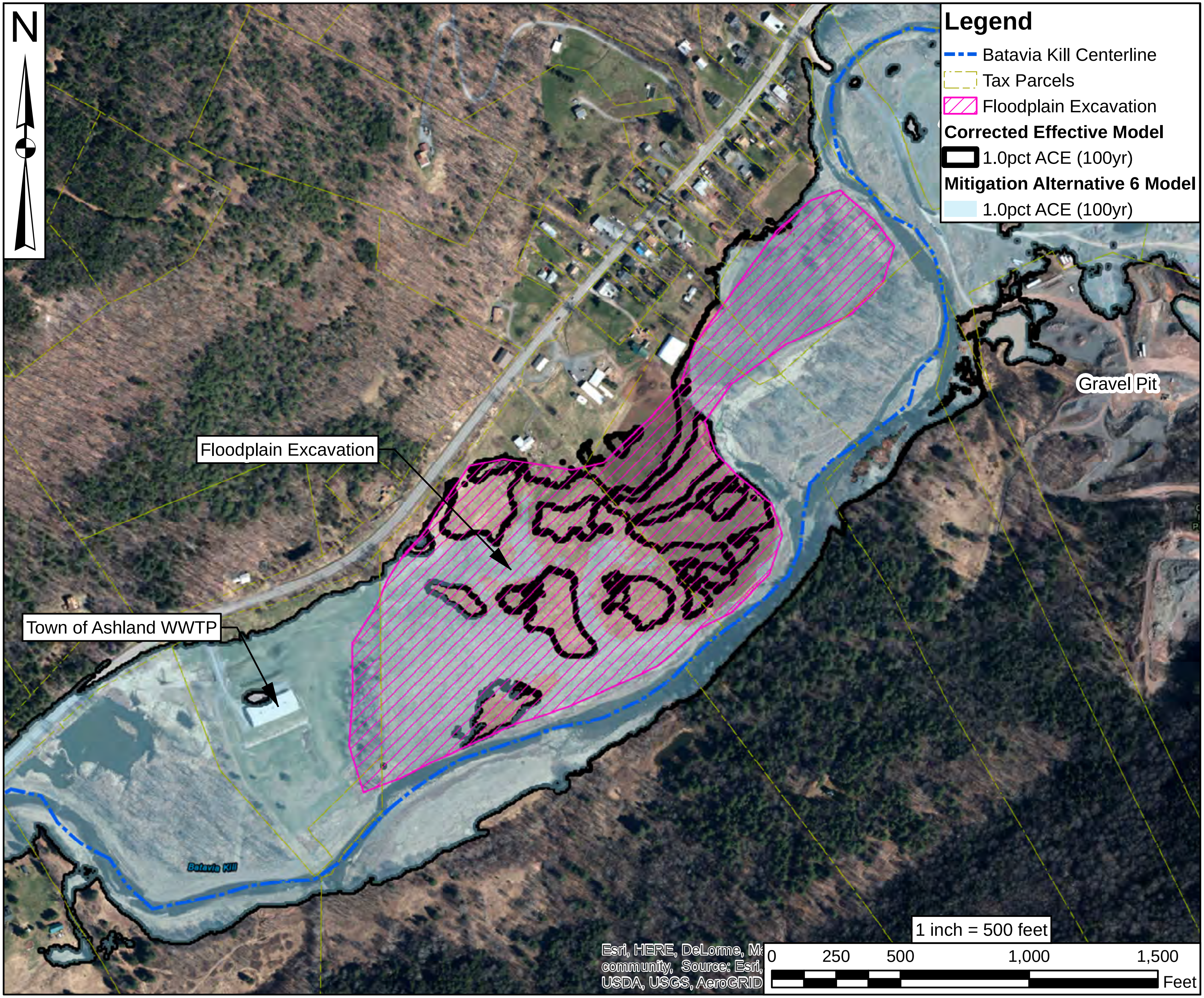

EXHIBIT 4f Floodplain Reclamation above WWTP

PREPARED BY:

Woidt Engineering & Consulting, P.C.
11 South Washington Street
Binghamton, New York 13903
www.woidtengineering.com

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PROJECT INFORMATION:

Local Flood Hazard Mitigation Project
Preliminary Flood Mitigation Alternatives
AUGUST 17th, 2018

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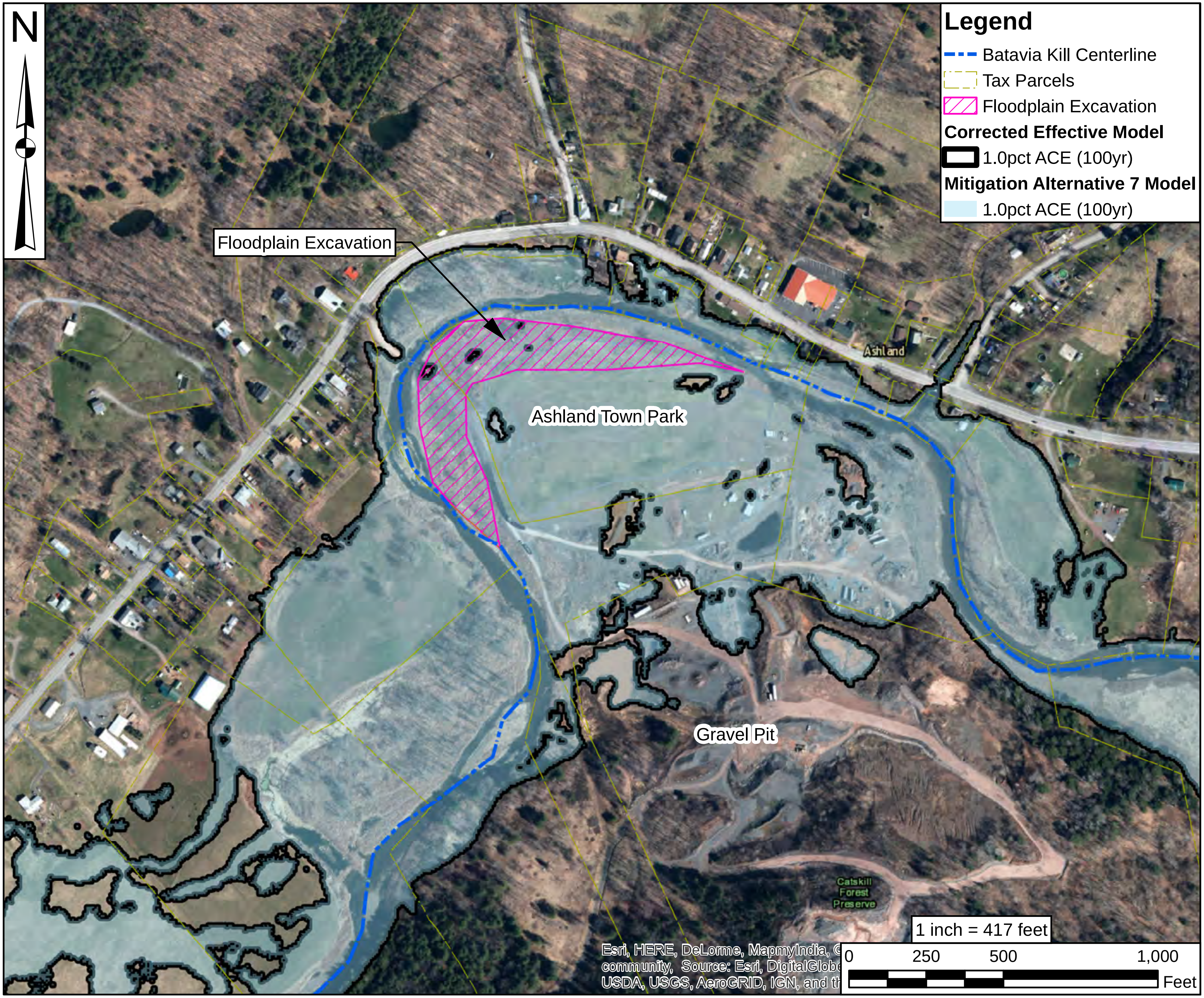

EXHIBIT 4g Floodplain Bench near Ashland Town Park

PREPARED BY:

Woidt Engineering & Consulting, P.C.
11 South Washington Street
Binghamton, New York 13903
www.woidtengineering.com

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PROJECT INFORMATION:

Local Flood Hazard Mitigation Project
Preliminary Flood Mitigation Alternatives
AUGUST 8th, 2018

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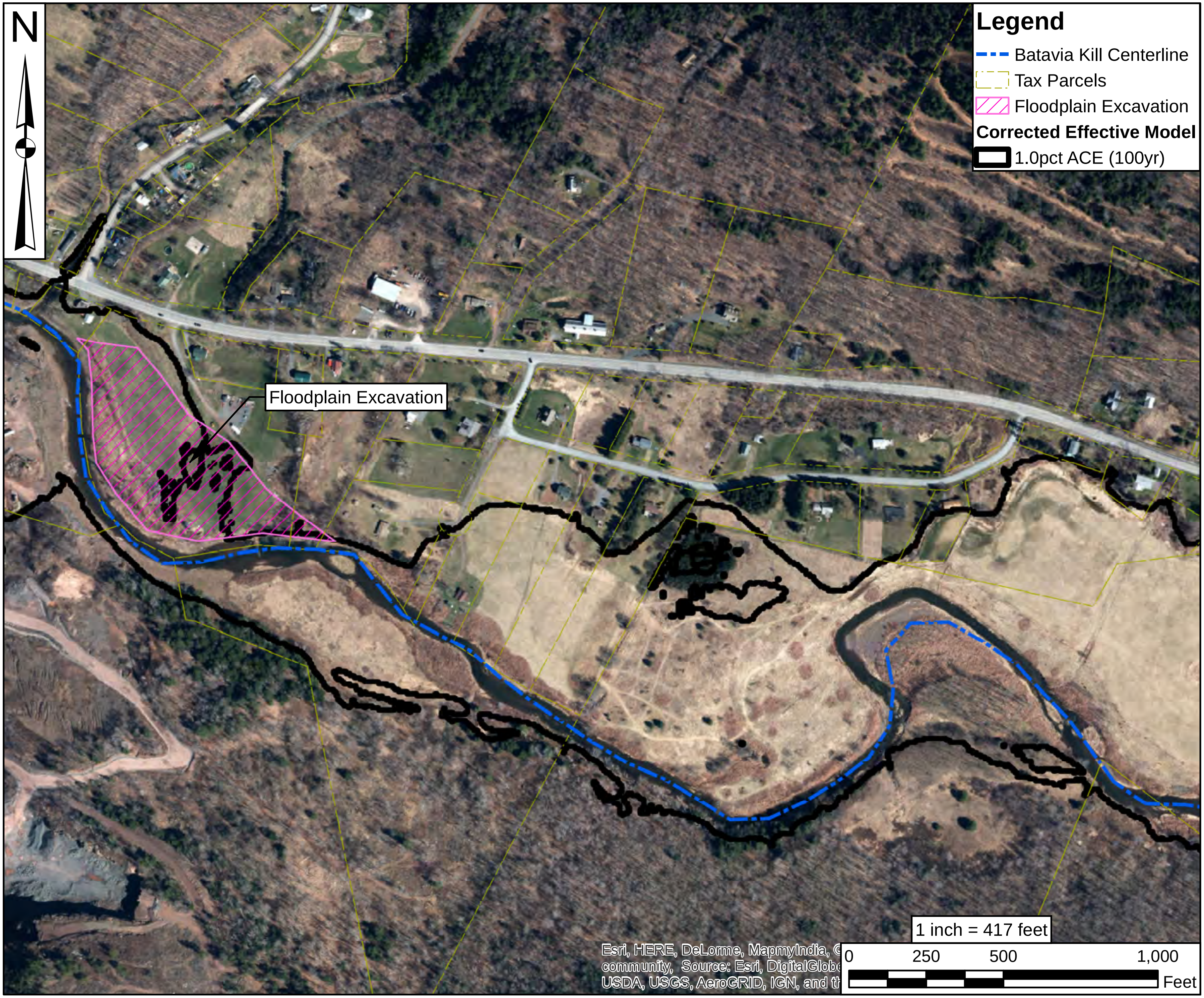

EXHIBIT 4h Floodplain Reclamation below Carrington Road

PREPARED BY:

Woidt Engineering & Consulting, P.C.
11 South Washington Street
Binghamton, New York 13903
www.woidtengineering.com

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PROJECT INFORMATION:

Local Flood Hazard Mitigation Project
Preliminary Flood Mitigation Alternatives
AUGUST 17th, 2018

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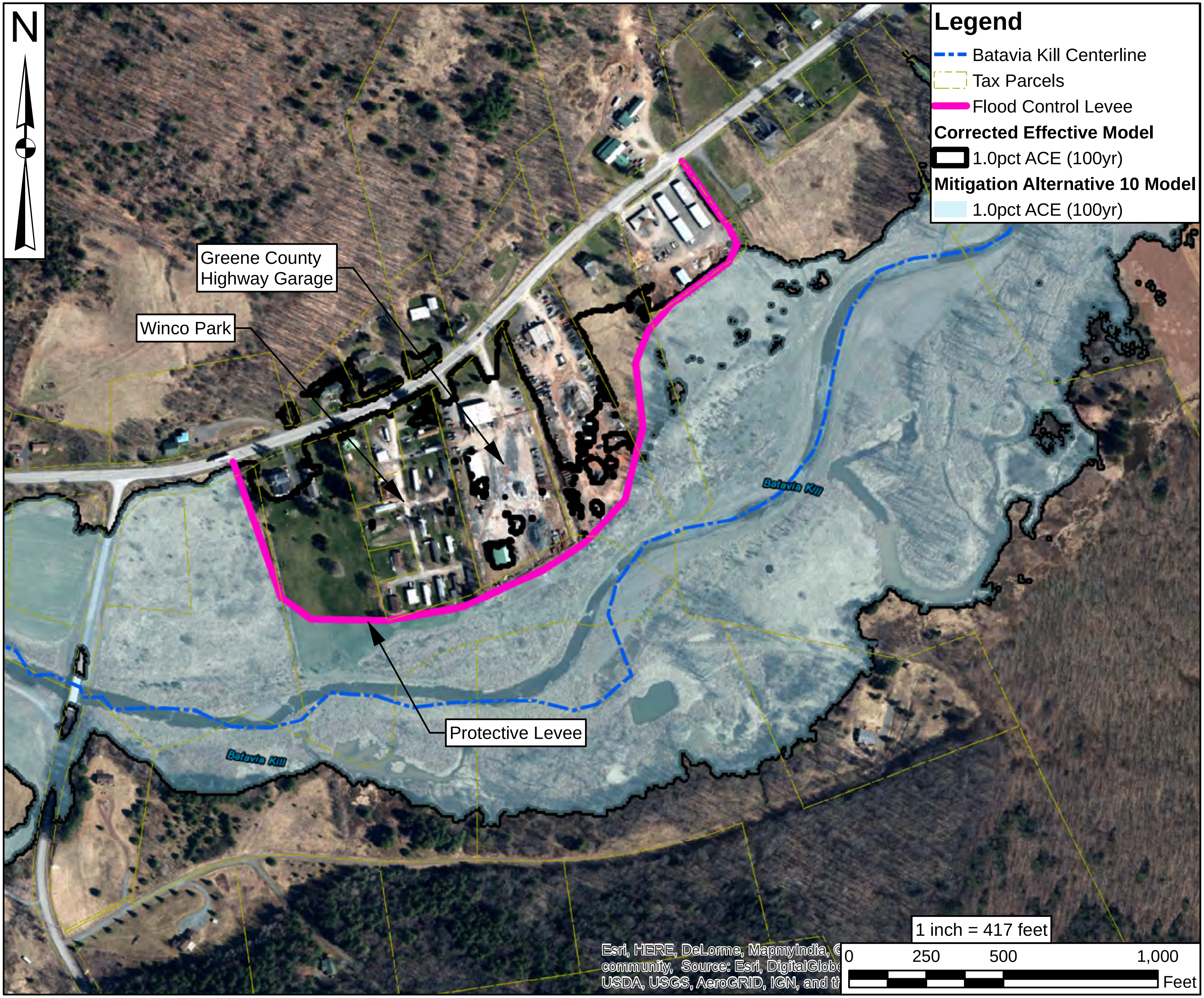

EXHIBIT 4i Protective Levee around Highway Garage and Winco Park

PREPARED BY:

Woidt Engineering & Consulting, P.C.
11 South Washington Street
Binghamton, New York 13903
www.woidtengineering.com

Woidt Engineering

PREPARED FOR:

Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection

PROJECT INFORMATION:

Local Flood Hazard Mitigation Project
Preliminary Flood Mitigation Alternatives
AUGUST 17th, 2018

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Appendix B

Detailed Cost Estimates and Benefit-Cost Analysis Results

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TITLE	**EXHIBIT 1. Engineer's Opinion of Probable Construction Cost**					
ALTERNATIVE	**Floodplain Relief Culvert Beneath County Road 17**					
DESIGN LEVEL	Screening (AACE Class V Estimate)					
DATE	8/16/2018					
ESTIMATE BY:	JLW					
CHECKED BY:	CFW					
BID ITEM #	ITEM	Unit	Unit Cost	Quantity	Total	Comment
1	Mobilization and Demobilization	LS	$14,474	1	$14,474	5% of Construction Subtotal
2	Site Clearing and Grubbing	AC	$5,000	0.4	$2,000	About 150 x 50 approach both sides
3	Floodplain Relief Culvert	LS	$250,000	1.0	$250,000	LS from NYSDOT cost-estimating tool
4	On-site Borrow & Fill	CY	$10	1,500	$15,000	For floodplain approaches
6	Site Restoration	AC	$20,000	0.4	$8,000	Fine grading, seeding, container plants
				Construction Subtotal	$289,474	Rounded to three significant figures
	Land Acquisition/Easement	AC	$7,500	0.4	$3,000	From current land listings
	Permitting	LS	$15,000	1	$25,000	SWPPP, Floodplain, Environ, Building
	Engineering	%	$289,474	10%	$28,947	Percent of Construction Subtotal
	Owner Administration	%	$346,421	10%	$34,642	Percent of above items
				Total Project Cost Estimate	**$381,100**	
				Low Total Project Cost Estimate	$190,550	Per AACE (-20% to -50%)
				High Total Project Cost Estimate	$762,200	Per AACE (+30% to +100%)

TITLE	**EXHIBIT 2. Engineer's Opinion of Probable Construction Cost**					
ALTERNATIVE	**Incremental Widening of County Road 17**					
DESIGN LEVEL	Screening (AACE Class V Estimate)					
DATE	8/16/2018					
ESTIMATE BY:	JLW					
CHECKED BY:	CFW					
BID ITEM #	ITEM	Unit	Unit Cost	Quantity	Total	Comment
1	Mobilization and Demobilization	LS	$62,915	1	$62,915	5% of Construction Subtotal
2	Site Clearing and Grubbing	AC	$5,000	2.0	$10,000	Approx. 85' x 1000' bench
3	Replacement Bridge	SF	$330	6,366	$2,100,780	Per SF cost for replaced CR 17 bridge
4	Less In-Kind Replacement	SF	-$330	3,183	-$1,050,390	Presumed paid by County
5	On-site Borrow & Fill	CY	$10	9,500	$95,000	For floodplain bench
6	Site Restoration	AC	$20,000	2.0	$40,000	Fine grading, seeding, container plants
				Construction Subtotal	$1,258,305	Rounded to three significant figures
	Land Acquisition/Easement	AC	$7,500	2.0	$15,000	From current land listings
	Permitting	LS	$15,000	1	$25,000	SWPPP, Floodplain, Environ, Building
	Engineering	%	$1,258,305	10%	$125,831	Percent of Construction Subtotal
	Owner Administration	%	$1,424,136	10%	$142,414	Percent of above items
				Total Project Cost Estimate	**$1,566,600**	
				Low Total Project Cost Estimate	$783,300	Per AACE (-20% to -50%)
				High Total Project Cost Estimate	$3,133,200	Per AACE (+30% to +100%)

TITLE	**EXHIBIT 3. Engineer's Opinion of Probable Construction Cost**					
ALTERNATIVE	**Relocation of Greene County Highway Garage**					
DESIGN LEVEL	Screening (AACE Class V Estimate)					
DATE	4/9/2018					
ESTIMATE BY:	JLW					
CHECKED BY:	CFW					
BID ITEM #	ITEM	Unit	Unit Cost	Quantity	Total	Comment
1	Mobilization and Demobilization	LS	$118,200	1	$118,200	5% of Construction Subtotal
2	Demolition of Existing Building	LS	$73,500	1	$73,500	10% of current structure value
3	Existing Site Restoration	AC	$8,500	5	$42,500	Backblade, mulch, seed
4	Site Grading & Development	SY	$45	4,840	$217,800	Grading, site development @ structure
5	Re-constructed DPW Facility	SF	$150	5,200	$780,000	For pre-fab metal occupied building
6	Re-constructed Salt Shed	SF	$70	3,600	$252,000	For pre-fab metal salt shed
6	Re-constructed Equipment Storage	SF	$25	6,000	$150,000	For pre-fab metal outbuilding
7	Storage Yard Grading	SY	$15	17,000	$255,000	Dozer work, compaction on flat ground
8	Stormwater Management	AC	$75,000	5	$375,000	For treatment of site runoff
9	Utility Connections	LS	$100,000	1	$100,000	Allowance, will vary with location
				Construction Subtotal	$2,364,000	Rounded to three significant figures
	Land Acquisition/Easement	AC	$7,500	5	$37,500	From current land listings
	Permitting	LS	$15,000	1	$15,000	SWPPP, building
	Engineering	%	$2,364,000	10%	$236,400	Percent of Construction Subtotal
	Owner Administration	%	$2,652,900	10%	$265,290	Percent of above items
				Total Project Cost Estimate	**$2,918,200**	
				Low Total Project Cost Estimate	$1,459,100	Per AACE (-20% to -50%)
				High Total Project Cost Estimate	$5,836,400	Per AACE (+30% to +100%)

TITLE	**EXHIBIT 4. Engineer's Opinion of Probable Construction Cost**					
ALTERNATIVE	**Protective Levee around Greene County Highway Garage, Winco Park, and B&B**					
DESIGN LEVEL	Screening (AACE Class V Estimate)					
DATE	8/16/2018					
ESTIMATE BY:	JLW					
CHECKED BY:	CFW					
BID ITEM #	ITEM	Unit	Unit Cost	Quantity	Total	Comment
1	Mobilization and Demobilization	LS	$65,263	1	$65,263	5% of Construction Subtotal
2	Site Clearing and Grubbing	AC	$5,000	5.2	$26,000	15' top width with 3:1 SS, 15' offsets
3	Silt Fence	LF	$4	3,000	$12,000	Silt fence, etc.
4	Imported Fill	CY	$100	5,000	$500,000	Assume clay core with 0.5:1 sideslope
5	On-site Borrow & Fill	CY	$20	15,500	$310,000	Assume side slopes of 3:1
6	Hydroseeding of Levee	SY	$2	25,000	$50,000	
7	Restoration of Borrow Site	AC	$20,000	2.1	$42,000	Fine grading, seeding, container plants
8	Interior Storm Drainage	LS	$300,000	1	$300,000	Interior pumping
				Construction Subtotal	$1,305,263	Rounded to three significant figures
	Land Acquisition/Easement	AC	$7,500	5	$37,500	From current land listings
	Permitting	LS	$50,000	1	$25,000	SWPPP, Floodplain, Environ, Building
	Engineering	%	$1,305,263	15%	$195,789	Percent of Construction Subtotal
	Owner Administration	%	$1,563,553	10%	$156,355	Percent of above items
				Total Project Cost Estimate	**$1,720,000**	
				Low Total Project Cost Estimate	$860,000	Per AACE (-20% to -50%)
				High Total Project Cost Estimate	$3,440,000	Per AACE (+30% to +100%)

Exhibit 5
Summary of Individual Property Acquisition and Elevation Cost-Benefit Ratios

Property ID	Acquisition Mitigation Project Benefits	Acquisition Costs	Acquisition BCR	Meets Simple FEMA Req? [a]	NYC Buyout Program? [b]	Elevation Mitigation Project Benefits	Elevation Costs	Elevation BCR	Meets Simple FEMA Req? [c]
101	$ 8,420	$ 337,600	0.02	No	No	$ 2,347	$ 156,396	0.02	No
110	$ 7,177	$ 194,100	0.04	Yes	No	$ -	$ 101,300	0.00	Yes
111	$ 6,804	$ 161,900	0.04	Yes	No	$ -	$ 59,638	0.00	Yes
120	$ 6,773	$ 150,100	0.05	Yes	No	$ -	$ 89,000	0.00	Yes
121	$ 12,280	$ 119,600	0.10	Yes	No	$ 4,720	$ 98,150	0.05	Yes
124	$ 45,905	$ 224,700	0.20	Yes	No	$ 26,913	$ 200,000	0.13	No
125	$ 3,523	$ 224,600	0.02	Yes	No	$ -	$ 118,850	0.00	Yes
126	$ 197,616	$ 157,100	1.26	Yes	No	$ 133,779	$ 104,000	1.29	Yes
127	$ 33,583	$ 149,900	0.22	Yes	No	$ 14,647	$ 138,500	0.11	Yes
128	$ 21,743	$ 91,400	0.24	Yes	No	$ 13,369	$ 60,653	0.22	Yes
129	$ 8,188	$ 28,200	0.29	Yes	No	$ 5,199	$ 46,565	0.11	Yes
130	$ 4,737	$ 65,200	0.07	Yes	No	$ 2,414	$ 44,917	0.05	Yes
131	$ 5,547	$ 28,000	0.20	Yes	No	$ 3,357	$ 38,960	0.09	Yes
132	$ 14,825	$ 28,300	0.52	Yes	Yes	$ 10,536	$ 54,618	0.19	Yes
133	$ 9,478	$ 28,300	0.33	Yes	No	$ 6,119	$ 51,842	0.12	Yes
134	$ 5,091	$ 28,000	0.18	Yes	No	$ 2,851	$ 40,376	0.07	Yes
135	$ 6,811	$ 28,200	0.24	Yes	No	$ 4,008	$ 49,250	0.08	Yes
136	$ 6,400	$ 28,100	0.23	Yes	No	$ 3,869	$ 44,185	0.09	Yes
137	$ 5,154	$ 28,300	0.18	Yes	No	$ 2,499	$ 51,094	0.05	Yes
138	$ 1,343	$ 27,600	0.05	Yes	No	$ 536	$ 20,238	0.03	Yes
139	$ 2,291	$ 28,000	0.08	Yes	No	$ 517	$ 40,205	0.01	Yes
141	$ 3,214	$ 28,500	0.11	Yes	No	$ 448	$ 60,965	0.01	Yes
142	$ 1,404	$ 27,900	0.05	Yes	No	$ -	$ 34,451	0.00	Yes
143	$ 14,973	$ 28,900	0.52	Yes	Yes	$ 9,783	$ 78,358	0.12	Yes
144	$ 3,952	$ 28,000	0.14	Yes	No	$ 1,962	$ 39,903	0.05	Yes
145	$ 5,412	$ 28,300	0.19	Yes	No	$ 2,612	$ 54,486	0.05	Yes
146	$ 13,629	$ 129,500	0.11	Yes	No	$ 3,435	$ 82,156	0.04	Yes
147	$ 3,914	$ 78,300	0.05	Yes	No	$ -	$ 59,000	0.00	Yes
148	$ 8,465	$ 260,700	0.03	Yes	No	$ -	$ 142,736	0.00	Yes
149	$ 3,208	$ 58,800	0.05	Yes	No	$ -	$ 59,568	0.00	Yes
151	$ 1,065	$ 180,400	0.01	No	No	$ -	$ 130,914	0.00	No
152	$ 4,472	$ 224,800	0.02	No	No	$ -	$ 147,650	0.00	No
153	$ 3,049	$ 187,700	0.02	Yes	No	$ -	$ 183,200	0.00	No

Exhibit 5
Summary of Individual Property Acquisition and Elevation Cost-Benefit Ratios

Property ID	Acquisition Mitigation Project Benefits	Acquisition Mitigation Project Costs	Acquisition BCR	Meets Simple FEMA Req? [a]	NYC Buyout Program? [b]	Elevation Mitigation Project Benefits	Elevation Mitigation Project Costs	Elevation BCR	Meets Simple FEMA Req? [c]
154	$ 2,640	$ 222,300	0.01	No	No	$ -	$ 164,000	0.00	No

[a] In a memo dated August 15, 2013, FEMA considers structures which are in a SFHA or have FFE below the BFE, and have acquisition costs less than $276,000, to be cost-effective

[b] Per the New York City-Funded Flood Buyout Program (NYCFFBO), structures eligible for acquisition are structures that have been substantially damaged previously or, based upon depth-damage analysis, is likely to be substantially damaged during a flood with a 1 percent or more frequent annual chance of occurence.

[c] In a memo dated August 15, 2013, FEMA considers structures which are in a SFHA or have FFE below the BFE, and have elevation costs less than $175,000, to be cost-effective

BFE = Base Flood Elevation; FFE = Finished Floor Elevation; SFHA = Special Flood Hazard Area