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DRAFT Phase 1 Hydraulic Analysis of the Sucker Brook Watershed

May 2, 2025

Sucker Brook Watershed

Task 2 and Task 3

City of Canandaigua, Ontario County NY

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Background

Colliers Engineering & Design (CED) has been retained by the City of Canandaigua to provide professional services which include an updated hydraulic study of the Sucker Brook watershed in the City and Town of Canandaigua, Ontario County, New York. The overall Sucker Brook watershed (**Figure 1**) consists of approximately 8.7 square miles of land of various uses ranging from high density development to cultivated crops.

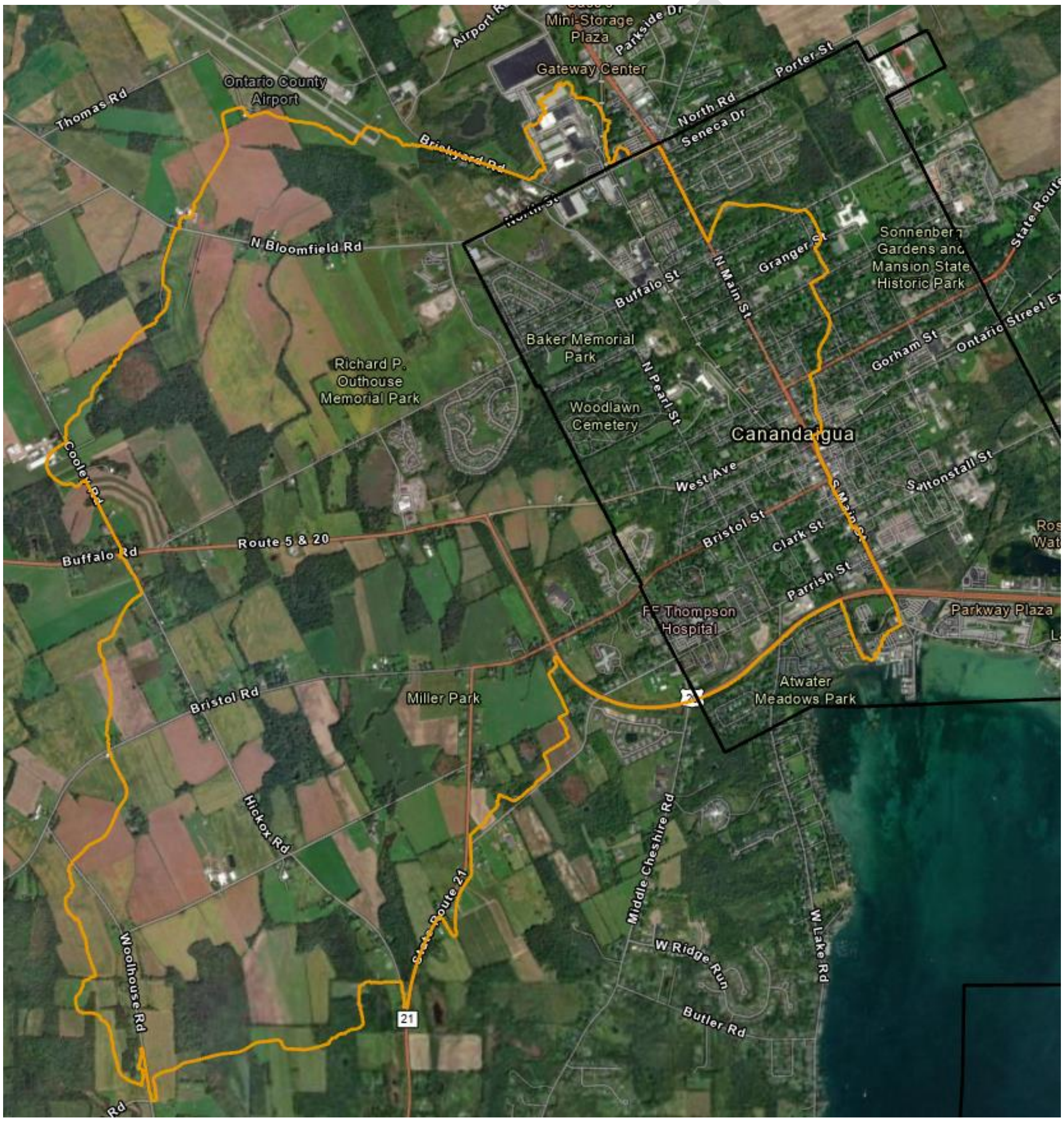

Figure 1: Sucker Brook watershed overlaid on aerial imagery

The City of Canandaigua is situated on the shore of Canandaigua Lake and is where the 8.7 square mile Sucker Brook watershed outlets. The area in and around Canandaigua is flat, as is typical of the areas surrounding the mouths of streams. Within the City, Sucker Brook has an average stream bed slope of 0.003 ft/ft. In the headwaters of Sucker Book, upstream of Canandaigua, the average bed slope ranges from 0.008 ft/ft to 0.014 ft/ft, 250% to 450% steeper than within the City. The difference in bed slopes is shown in the stream profile in Figure 2 below. The higher bed slopes found in the headwaters of Sucker Brook can convey flood flows more efficiently than the lower slopes near the mouth, where the City of Canandaigua is located. Once the flood flows reach the City, they naturally spread out onto the floodplain, and significant flooding results.

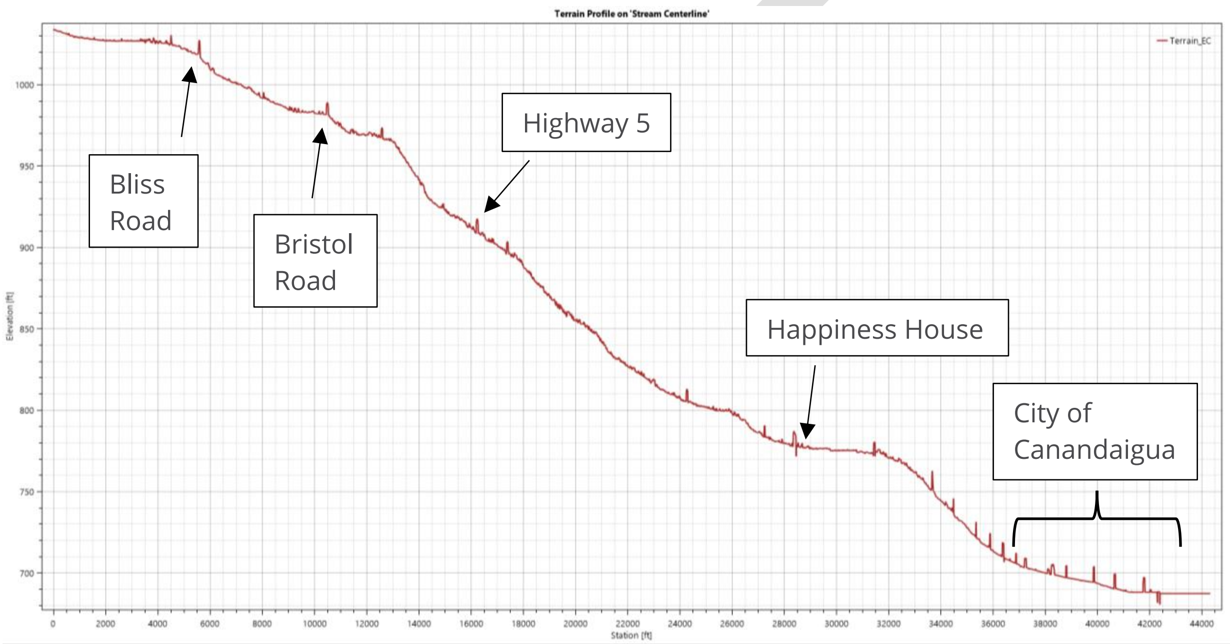

Figure 2: Sucker Brook Stream Centerline Terrain Profile

There is a history of flooding along Sucker Brook and in the City of Canandaigua, with the most recent major event on July 9th, 2023. According to the rainfall data recorded at the Canandaigua Airport and posted on Weather.gov, the six hour rainfall total for the July 9th event was 5.55 inches. This rainfall total equates to a greater than 1000-year rainfall event according to the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Precipitation Frequency Estimate Table for the area (Table 1). Rainfall does not exactly equate to runoff, as factors such as soil saturation and flow attenuation in the watershed can both increase and decrease peak flows, so, for example, it cannot be assumed that the 1000-year rainfall event would cause a 1000-year flood event. If the soil was saturated with rain prior to the July 9th storm, flows in excess of the 1000+ year recurrence interval could have occurred.

Table 1: NOAA Atlas 14 Rainfall Frequency Estimates

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.270 (0.211-0.342)	0.329 (0.257-0.416)	0.425 (0.330-0.539)	0.504 (0.390-0.643)	0.613 (0.459-0.815)	0.695 (0.511-0.941)	0.782 (0.557-1.10)	0.880 (0.593-1.25)	1.02 (0.663-1.50)	1.14 (0.722-1.70)
10-min	0.383 (0.299-0.485)	0.466 (0.363-0.590)	0.602 (0.468-0.764)	0.714 (0.552-0.911)	0.869 (0.650-1.16)	0.985 (0.723-1.34)	1.11 (0.789-1.55)	1.25 (0.840-1.78)	1.45 (0.939-2.13)	1.62 (1.02-2.42)
15-min	0.451 (0.352-0.570)	0.548 (0.428-0.694)	0.707 (0.549-0.898)	0.840 (0.649-1.07)	1.02 (0.765-1.36)	1.16 (0.850-1.57)	1.30 (0.929-1.83)	1.47 (0.988-2.09)	1.70 (1.10-2.50)	1.90 (1.20-2.84)
30-min	0.613 (0.479-0.775)	0.746 (0.581-0.944)	0.963 (0.748-1.22)	1.14 (0.883-1.46)	1.39 (1.04-1.85)	1.58 (1.16-2.14)	1.77 (1.26-2.48)	2.00 (1.34-2.84)	2.32 (1.50-3.41)	2.59 (1.64-3.87)
60-min	0.775 (0.605-0.980)	0.943 (0.735-1.19)	1.22 (0.947-1.55)	1.44 (1.12-1.84)	1.76 (1.32-2.34)	1.99 (1.46-2.70)	2.24 (1.60-3.14)	2.52 (1.70-3.60)	2.93 (1.90-4.31)	3.27 (2.07-4.89)
2-hr	0.954 (0.749-1.20)	1.15 (0.904-1.45)	1.48 (1.15-1.86)	1.74 (1.36-2.21)	2.11 (1.59-2.78)	2.39 (1.76-3.21)	2.68 (1.92-3.72)	3.01 (2.04-4.24)	3.48 (2.27-5.06)	3.86 (2.46-5.72)
3-hr	1.07 (0.844-1.34)	1.29 (1.01-1.61)	1.64 (1.28-2.06)	1.93 (1.50-2.44)	2.33 (1.76-3.06)	2.63 (1.95-3.52)	2.95 (2.12-4.06)	3.30 (2.25-4.63)	3.81 (2.49-5.50)	4.22 (2.69-6.20)
6-hr	1.30 (1.03-1.62)	1.55 (1.23-1.93)	1.95 (1.54-2.43)	2.29 (1.79-2.86)	2.75 (2.08-3.57)	3.09 (2.30-4.09)	3.46 (2.49-4.71)	3.86 (2.64-5.36)	4.42 (2.91-6.32)	4.88 (3.13-7.10)
12-hr	1.57 (1.25-1.94)	1.86 (1.48-2.29)	2.32 (1.84-2.87)	2.70 (2.13-3.36)	3.23 (2.47-4.16)	3.63 (2.71-4.76)	4.05 (2.93-5.46)	4.50 (3.10-6.19)	5.14 (3.40-7.28)	5.66 (3.66-8.15)
24-hr	1.86 (1.49-2.28)	2.19 (1.76-2.69)	2.72 (2.18-3.35)	3.17 (2.52-3.91)	3.78 (2.90-4.83)	4.24 (3.19-5.51)	4.72 (3.44-6.31)	5.25 (3.63-7.14)	6.00 (3.99-8.40)	6.61 (4.29-9.40)
2-day	2.16 (1.75-2.64)	2.54 (2.05-3.10)	3.16 (2.54-3.86)	3.67 (2.93-4.51)	4.38 (3.38-5.56)	4.91 (3.72-6.33)	5.46 (4.02-7.26)	6.09 (4.24-8.21)	6.99 (4.68-9.68)	7.72 (5.04-10.9)
3-day	2.38 (1.93-2.89)	2.79 (2.26-3.39)	3.46 (2.79-4.21)	4.02 (3.22-4.91)	4.78 (3.71-6.04)	5.35 (4.07-6.87)	5.96 (4.39-7.87)	6.64 (4.63-8.90)	7.62 (5.11-10.5)	8.43 (5.52-11.8)
4-day	2.57 (2.09-3.11)	3.00 (2.44-3.64)	3.71 (3.00-4.50)	4.29 (3.45-5.23)	5.10 (3.97-6.42)	5.70 (4.35-7.30)	6.34 (4.69-8.35)	7.06 (4.94-9.42)	8.10 (5.45-11.1)	8.95 (5.88-12.5)
7-day	3.06 (2.50-3.68)	3.54 (2.89-4.26)	4.33 (3.52-5.22)	4.98 (4.02-6.03)	5.87 (4.59-7.34)	6.55 (5.01-8.31)	7.26 (5.38-9.46)	8.04 (5.66-10.6)	9.16 (6.20-12.4)	10.1 (6.64-13.9)
10-day	3.53 (2.90-4.24)	4.05 (3.32-4.86)	4.90 (3.99-5.88)	5.60 (4.54-6.75)	6.56 (5.14-8.15)	7.29 (5.59-9.20)	8.05 (5.98-10.4)	8.87 (6.26-11.7)	10.0 (6.81-13.5)	11.0 (7.25-15.0)
20-day	5.02 (4.14-5.97)	5.62 (4.63-6.70)	6.61 (5.43-7.89)	7.43 (6.06-8.91)	8.56 (6.75-10.5)	9.43 (7.26-11.7)	10.3 (7.66-13.1)	11.2 (7.97-14.6)	12.4 (8.47-16.6)	13.3 (8.86-18.1)
30-day	6.29 (5.21-7.46)	6.96 (5.75-8.26)	8.06 (6.64-9.57)	8.96 (7.34-10.7)	10.2 (8.07-12.5)	11.2 (8.63-13.8)	12.1 (9.03-15.3)	13.1 (9.34-16.9)	14.3 (9.80-18.9)	15.2 (10.1-20.4)
45-day	7.91 (6.57-9.33)	8.65 (7.18-10.2)	9.86 (8.15-11.7)	10.9 (8.93-12.9)	12.3 (9.71-14.9)	13.3 (10.3-16.4)	14.4 (10.7-18.0)	15.4 (11.0-19.7)	16.6 (11.4-21.8)	17.4 (11.7-23.3)
60-day	9.28 (7.73-10.9)	10.1 (8.38-11.9)	11.4 (9.44-13.4)	12.5 (10.3-14.8)	14.0 (11.1-16.9)	15.1 (11.7-18.5)	16.3 (12.1-20.2)	17.3 (12.4-22.1)	18.5 (12.8-24.2)	19.3 (13.0-25.7)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

This report will outline the existing flooding problems within the City of Canandaigua due to Sucker Brook and give an overview of the CED hydrologic and hydraulic studies to quantify flooding. Three construction alternatives: increasing the capacity of bridges, floodplain benching, and berm construction will be evaluated. Alternatives evaluated outside of major infrastructure improvements are voluntary buyouts, voluntary home relocation, home elevation, individual mitigation strategies such as removing utilities from the basement, and upstream detention/wetland rehabilitation. Potential grant funding sources for each alternative will also be discussed.

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Existing Data Review

Prior to the start of the modeling, a comprehensive review of available data was performed. The Sucker Brook watershed has been the subject of prior studies, and the City, Town, and County all had data relevant to this study. A list of data reviewed for this study is below.

Stormwater Management Study for the Sucker Brook Watershed – MRB Group, 2006

A comprehensive engineering study of the Sucker Brook watershed was completed in 2006 by MRB Group. The study evaluated peak flow rates for various storm intensities from 55 subbasins of Sucker Brook along with providing peak flow rates at 42 structures and 39 channel reaches. This study served as the basis for the hydrologic analysis performed by CED.

Engineers Report for Hydrologic and Hydraulic Study for Southern Drainage area for Woodlawn Cemetery Storm Sewer – Lu Engineers, 2024

A study of the hydrology of the area draining to the Woodlawn Cemetery culvert was completed in 2024 by Lu Engineers. The study analyzed a 248-acre drainage area using WinTR-55, and developed peak flows for the 2, 5, 10, 25, 50, and 100-year storm events. This study served as a comparison to the analysis performed by CED for the area around Woodlawn Cemetery.

Effective Flood Insurance Study for the City of Canandaigua - October 1st, 1980, and Preliminary Flood Insurance Study for Ontario County – July 14th, 2023

Both the Effective and Preliminary Flood Insurance Studies (FIS) for the area were utilized as a part of this analysis. Peak flows and inundation areas calculated in the CED analysis within the City of Canandaigua were compared to those calculated in the Preliminary FIS. The Effective Floodway was compared to the Preliminary Floodway and used to evaluate alternatives in the analysis.

2019 FEMA Digital Elevation Model

A 1-meter by 1-meter digital elevation model (DEM), collected by the Federal Emergency Management Agency (FEMA) in 2019 was obtained from the Discover GIS Data NY download site. This DEM matches the 1ft contour shapefile available on the Ontario County GIS Website, as they share the same data source (the 2019 FEMA LiDAR). The 1-meter by 1-meter DEM was used as the terrain for both the hydrologic and hydraulic analyses.

2023 National Landcover Database Land Cover Raster

A land cover raster was obtained from the National Land Cover Database (NLCD) MRLC Viewer. The land cover raster was converted to a polygon shapefile, and in the process the polygons were smoothed into simpler shapes. Manual edits were made to the polygons to account for known drainage improvement projects within the Sucker Brook watershed. The land cover polygons were converted to Manning's n values based on the typical published values for each cover type and used for both the hydrologic and hydraulic analyses. Classification polygons were incorporated to the land cover layer to refine it so that the land cover type of Sucker Brook and its tributaries corresponded to Open Water.

2024 Eagle View Orthoimagery

2024 Orthoimagery was downloaded from the Ontario County GIS Data Resources website. This imagery was used to update the NLCD Landcover dataset with development that was not captured in the 2023 Landcover Data.

Various Shapefiles on Drainage Area, Flow Paths, Culverts, and Detention Projects

The work completed prior to this study in the Sucker Brook Watershed developed various shapefiles that were useful in this study. This data was incorporated into the study where applicable.

Hydrologic Analysis

A hydrologic analysis was performed for the Sucker Brook watershed using GeoHECHMS v1.3.0.2798 and the United States Army Corps of Engineers (USACE) HEC-HMS hydrologic software (v4.9). The 8.7 square mile watershed was broken up into 25 drainage areas, and a hydrograph was developed for each drainage area (Figure 3). Each flow hydrograph was input into the hydraulic model at the upstream end of each subbasin to account for flow routing. Details on this hydrologic analysis can be found in the Sucker Brook Watershed – Hydrologic Analysis included in Appendix 1.

Future Increases in Precipitation

In Ontario County, the New York State Department of Transportation requires an increase in peak flows of 10% for all bridge and culvert replacement projects to account for future projected peak flows. This increase is based on the USGS developed Future StreamStats Tool, which uses future annual precipitation from climate and greenhouse gas emissions models to predict the corresponding increases in flows due to increased precipitation. In order to consider increases in precipitation, the 100-year flows for each subbasin generated in the hydrologic analysis were increased by 10% and then compared to the 100-year and 500-year flows in Table 2.

Table 2: Modeled 100- and 500-year flows vs climate change scenario of the 100-year plus 10%

	Peak Discharge (cfs)			% Difference	
Subbasin No.	100-year	100-year +10%	500-year	500 vs 100+10%	500 vs 100
1	239	263	346	31%	45%
2	153	169	237	40%	54%
3	274	301	412	37%	51%
4	169	186	247	33%	46%
5	176	194	246	27%	40%
6	45	49	62	27%	40%
7	153	169	207	23%	35%
8	140	154	193	25%	38%
9	334	367	497	35%	49%
10	79	87	115	32%	45%
11	310	341	447	31%	44%
12	154	170	226	33%	46%
13	737	811	1096	35%	49%
14	69	75	92	22%	35%
15	321	353	452	28%	41%
16	516	567	706	24%	37%
17	303	333	467	40%	54%
18	260	285	372	30%	43%
19	53	58	74	27%	40%
20	112	123	170	37%	51%
21	80	88	109	24%	36%
22	116	128	161	26%	38%
23	441	485	669	38%	52%
24	107	117	164	40%	54%
25	225	248	328	32%	46%

The 100-year + 10% peak flows are lower than the 500-year and were therefore not analyzed in the hydraulic modeling. The 500-year hydrographs were included in the hydraulic modeling and can be used to evaluate the effects of future increases in precipitation.

Figure 3: Map of the 25 subbasins

Hydraulic Analysis Methodology

To perform the hydraulic analysis, CED created a two-dimensional (2D) unsteady-state hydraulic model. This model was developed using the USACE HEC-RAS hydraulic software (v6.6).

A 2D flow area with an area corresponding to the 25-sub-basin Sucker Brook watershed delineated from the Hydrologic Analysis (Task 1) was used for the model. An average cell spacing of 100 ft by 100 ft was used with breaklines drawn along the stream centerlines, roadways, and other important features and enforced with 25 ft near spacing. An overview of the model geometry is included below in Figure 4.

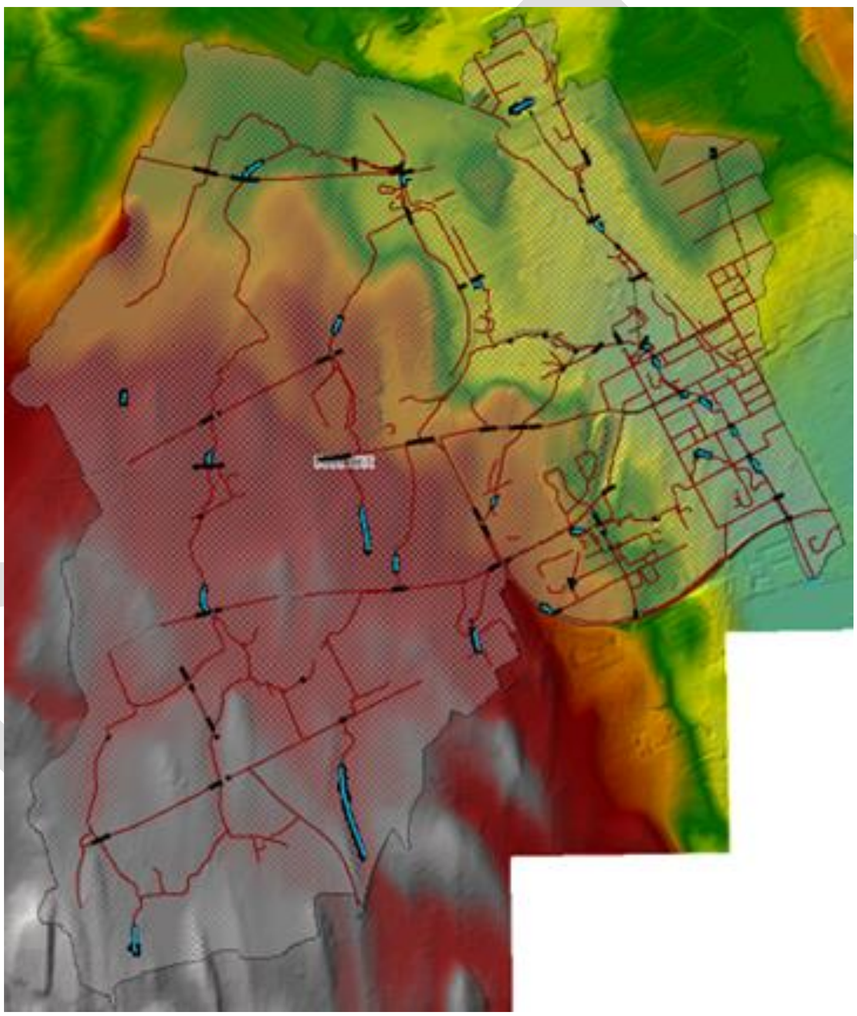

Figure 4: HEC-RAS 2D model geometry

SA/2D connections were added to the model to incorporate bridge and culvert crossings. Dimensions for bridges and culverts were obtained from the Stormwater Management Study by MRB Group and verified using CONNECTExplorer aerial imagery. Terrain modifications were incorporated to correct bridge and culvert inverts where the LiDAR could not pick up the elevations accurately.

The sub-basin inflow boundary conditions (BCs) were set to the hydrographs developed from the Task 1 Hydrologic Analysis. The downstream BC was set to normal depth at 0.001 which was measured off the FEMA profile for Sucker Brook in the Ontario County Preliminary Flood Insurance Study (FIS). Model scenarios were performed for the 2-, 10-, 25-, 50-, 100-, and 500-year events.

The model as described thus far was used as the Existing Conditions model. An overview of the inundation limits and depth of flooding in the 100-year storm can be found in Figures 5 and 6 below. The darker the shade of blue, the higher the depth of flooding.

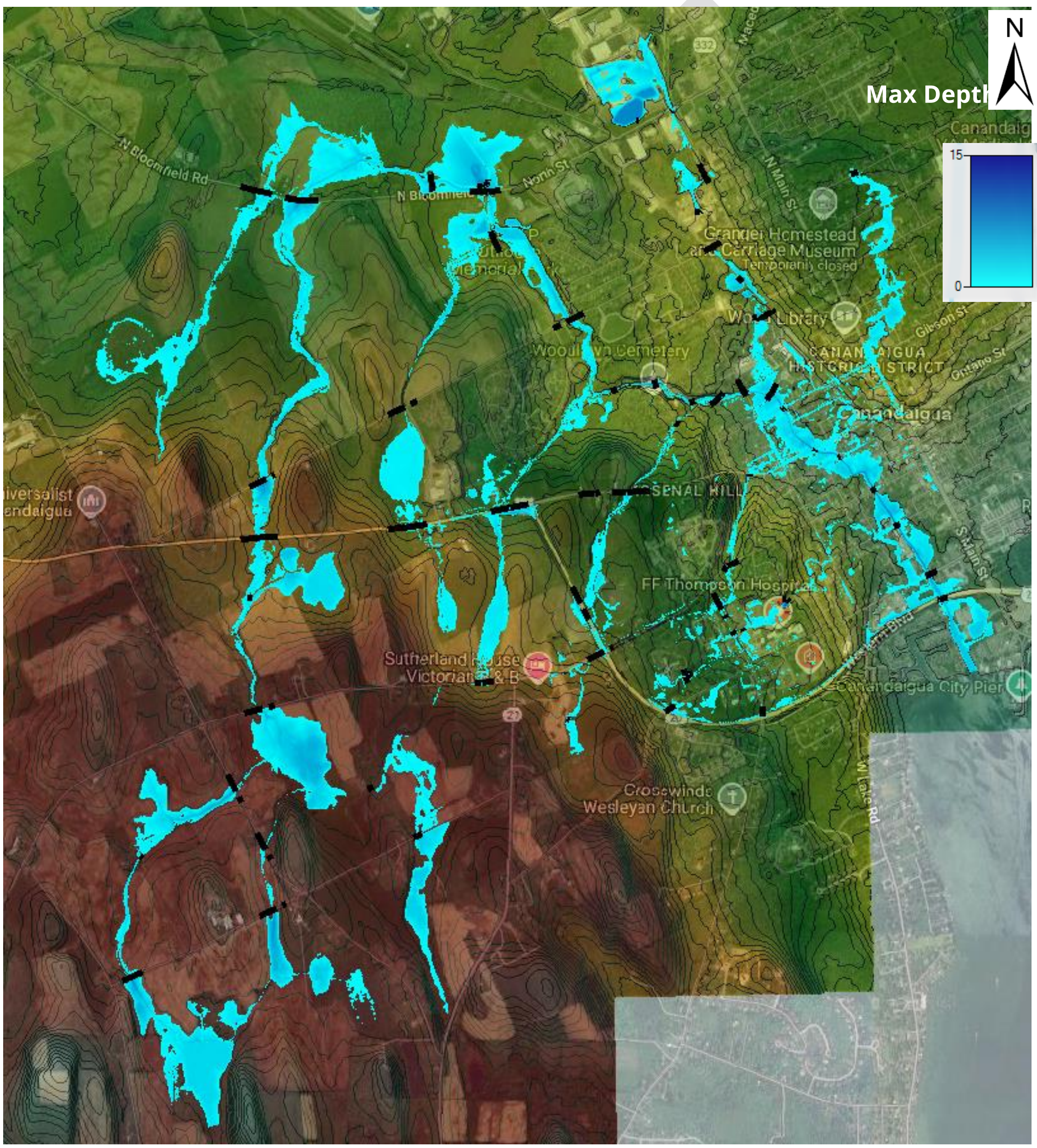

Figure 5: Existing Inundation Limits

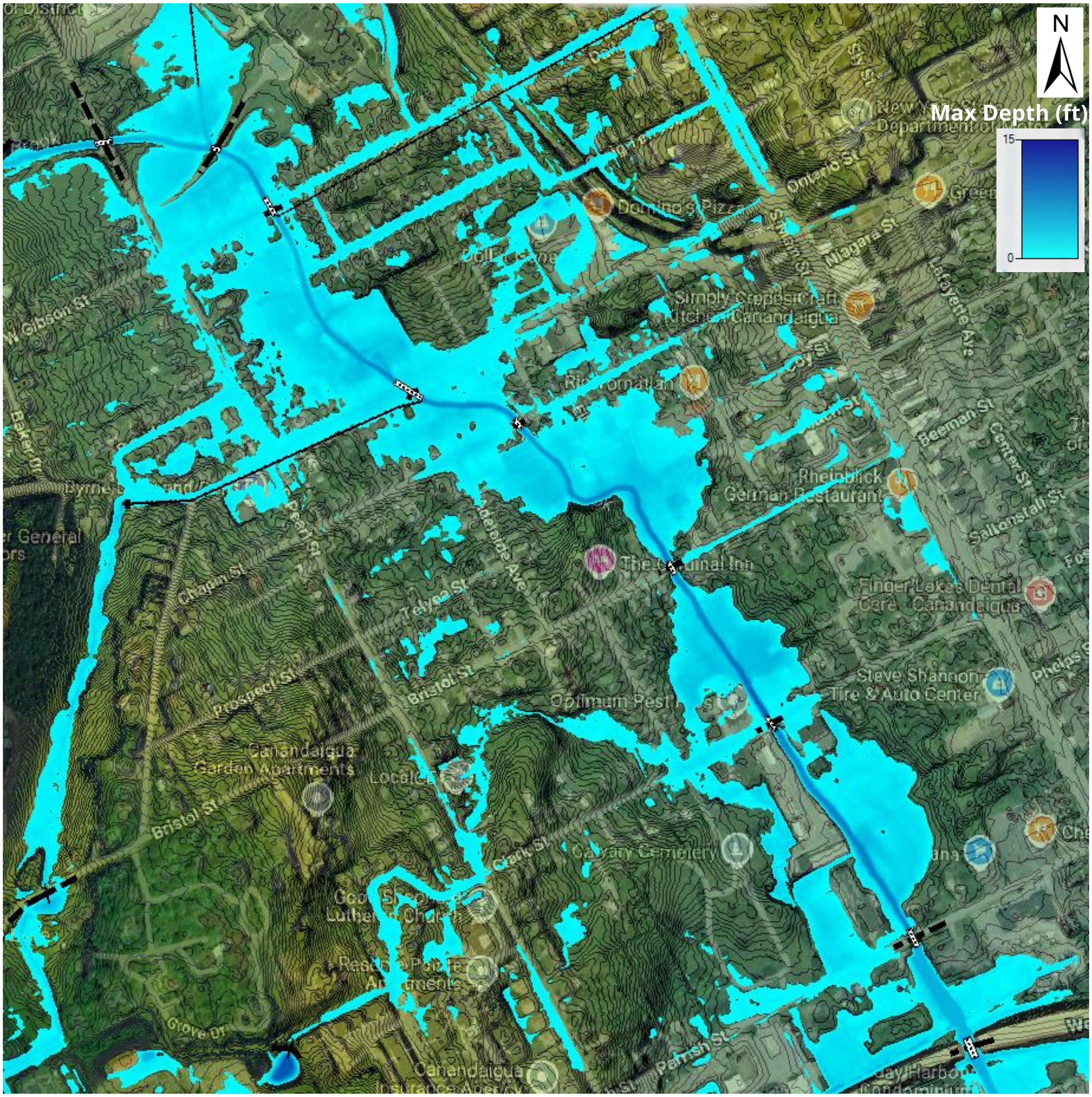

Figure 6: Existing Inundation Limits within the City of Canandaigua

The bridge structures in the downtown area of the City were evaluated and ranked based on the Existing Conditions modeling for which storm return period the road overtops (Table 3). While West Gibson Street, West Avenue, and Chapin Street all overtop during the 10-year storm, they do not overtop directly over where Sucker Brook goes under the road, but at a low point on the road. As flood levels increase, the water overtops the stream banks of Sucker Brook and flows in the path of least resistance to low areas. See Figure 7 for an example of this at Chapin Street.

Table 3: Ranking of undersized bridges

Street Name	Overtopping Event	Existing Span (ft)	Existing Rise (ft)
West Gibson	10 Year	19	4.8
West Ave.	10 Year	25	2.9
Chapin	10 Year	22	5.5
School Drive	25 Year	24	5.1
Clark	100 Year	18	8.6
Bristol	500 Year	22	8.7
Parrish	500 Year	22.8	10

The above dimensions in Table 3 are the existing conditions as measured during CED's site visit. During that visit, deposition of sediment was observed within the bridge opening at West Gibson, West Ave, Chapin, and the School Drive. The greatest amount of deposition was observed at West Ave, where 2.9 feet of sediment was measured in the opening. This reduced the effective bridge rise from 5.8 feet to 2.9 feet. Deposition occurs when fast moving, sediment laden water slows down suddenly, and the sediment falls out of suspension. Due to the change in stream bed slope previously discussed (Figure 2), this is not unexpected. Fast moving water carrying sediment from the upstream drainage areas slows down once it hits the shallow bed slope within the City of Canandaigua and deposits sediment.

While cleaning the sediment out of these bridges may increase the bridge capacity in the short term, the upstream conditions and bed slope through the city will cause the sediment to return after the first major storm event. Therefore, other alternatives to address the slow-moving water are necessary.

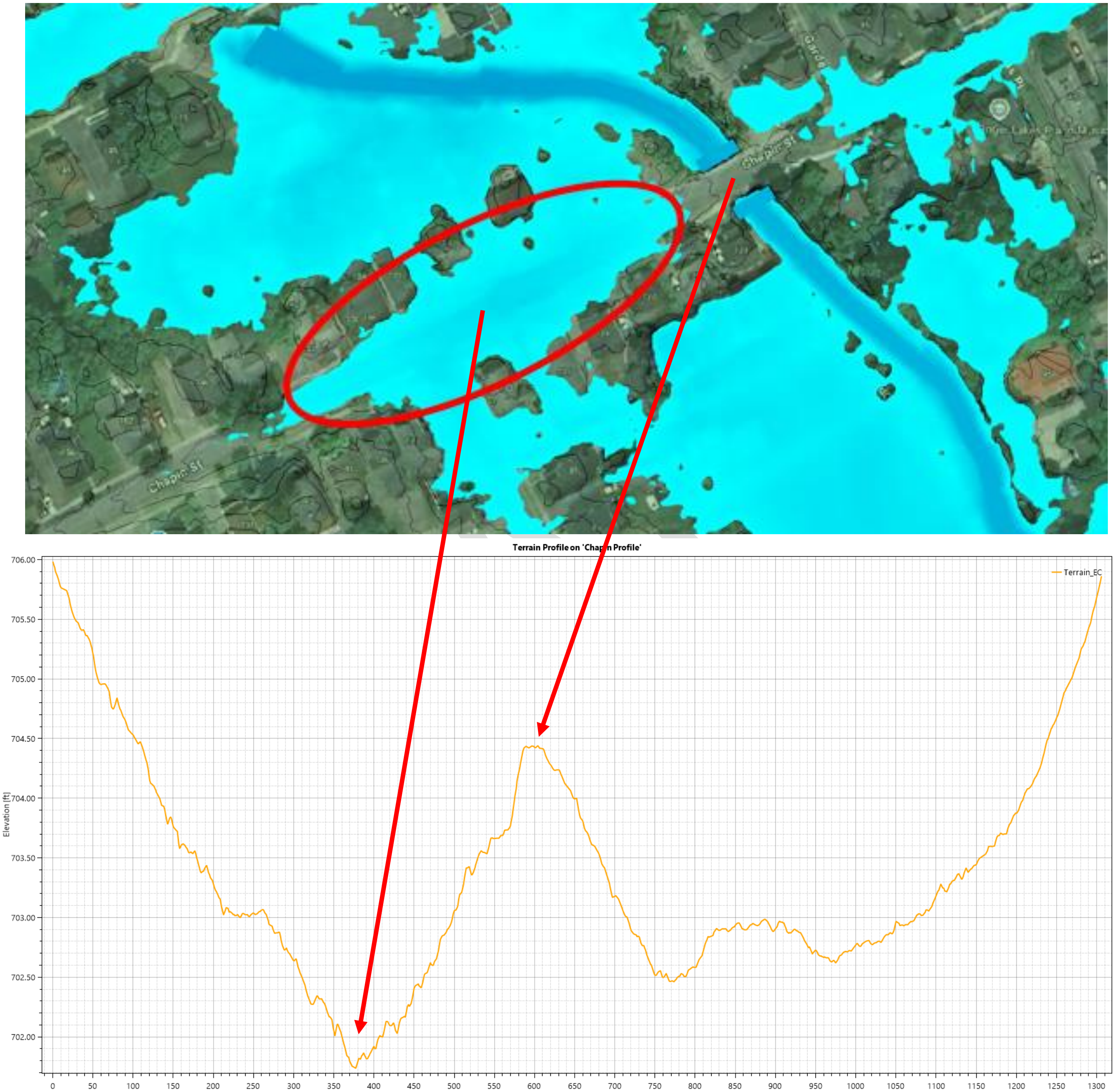

Figure 7: Flooding at Chapin St during the Existing 10-year event and the corresponding road profile

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Evaluate Undersized Bridge Structures – Alternative 1

Existing Bridge Conditions

The bridge structures crossing Sucker Brook upstream from North Pearl Street, downstream to Parrish Street were evaluated for flow capacity. An analysis of the incoming streamflow compared to the bridge flow for each return period revealed that the bridges at West Gibson Street, West Avenue, and Chapin Street are all drastically undersized, and unable to pass the 10-year flow. The bridge at the Canandaigua Primary-Elementary School driveway is also undersized, and unable to pass the 25-year flow. Clark Street and Parrish Street are undersized at the 100-year flow, but only marginally when compared to the other four undersized bridges. Table 4 shows the analysis of which bridge structures are undersized for which storm events and what percentage undersized they are.

Table 4 also showcases the difference in flow from the town/western portion of the watershed, upstream of North Pearl, vs the flow coming from the city/eastern portion of the watershed. The difference in flows between North Pearl and Parrish Street can be used to approximate the flows coming in from the City of Canandaigua vs the rest of the watershed. In the 100-year event, this difference is 280 cfs.

Table 4: Analysis of existing conditions flows passed by each bridge compared to the flow received

Street Name	2-year Flow (cfs)	2-year Culvert Flow (cfs)	% Under Capacity
N Pearl	150	150	0
School	170	170	0
W Gibson	170	170	0
West	180	180	0
Chapin	200	200	0
Bristol	200	200	0
Clark	210	210	0
Parrish	210	210	0

Street Name	10-year Flow (cfs)	10-year Culvert Flow (cfs)	% Under Capacity
N Pearl	360	360	0
School	400	400	0
W Gibson	400	380	5
West	400	390	3
Chapin	420	380	10
Bristol	420	420	0
Clark	420	420	0
Parrish	430	430	0

Street Name	25-year Flow (cfs)	25-year Culvert Flow (cfs)	% Under Capacity
N Pearl	490	490	0
School	570	530	7
W Gibson	570	420	26
West	580	430	26
Chapin	610	480	21
Bristol	610	610	0
Clark	610	610	0
Parrish	620	620	0

Street Name	50- year Flow (cfs)	50- year Culvert Flow (cfs)	% Under Capacity
N Pearl	580	580	0
School	700	570	19
W Gibson	710	420	41
West	720	440	39
Chapin	770	550	29
Bristol	770	770	0
Clark	770	770	0
Parrish	790	790	0

Street Name	100-year Flow (cfs)	100-year Culvert Flow (cfs)	% Under Capacity
N Pearl	690	690	0
School	830	600	28
W Gibson	830	430	48
West	870	440	49
Chapin	960	610	36
Bristol	960	960	0
Clark	960	890	7
Parrish	970	930	4

Street Name	500-year Flow (cfs)	500-year Culvert Flow (cfs)	% Under Capacity
N Pearl	890	890	0
School	1170	640	45
W Gibson	1260	430	66
West	1420	440	69
Chapin	1500	690	54
Bristol	1500	1480	1
Clark	1510	900	40
Parrish	1570	1270	19

Increased Bridge Capacity Conditions

To improve flow conditions and attempt to decrease water surface elevations (WSELs), an alternative was designed to increase the flow capacity for the School, West Gibson, West, and Chapin bridges. The School and Chapin bridges were widened based on the USACE standard of 1.25 multiplied by the width of the incoming channel. The School Drive bridge was widened from a width of 24 ft to 33 ft. The Chapin Street bridge was widened from a width of 22 ft to a width of 35 ft. The West Gibson and West Ave bridges were kept using the same dimensions as existing conditions, but instead each incorporated an additional 10 ft wide by 3 ft high floodplain culvert. This was done because incorporating a floodplain culvert rather than widening the actual bridge could be more feasible as it wouldn't be necessary to reconstruct the entire bridge. Due to the size and location of the floodplain culverts and the proximity of nearby properties, it will be necessary for some voluntary home buyouts to occur before it would be feasible to install the floodplain culverts. The floodplain culverts would also likely require some channel modifications up- and downstream to direct flow. Floodplain culverts could also be a potential option for both School Drive and Chapin Street – rather than widening these bridge openings – as well as Clark Street further downstream.

Table 5 shows the comparison of the incoming flows compared to the new bridge flow expected due to the proposed bridge modifications. It is important to note that the incoming flows are not all the same as the incoming flows presented in Table 4. This is because widening bridges upstream will allow a greater amount of flow to proceed downstream. By adding auxiliary floodplain culverts to West Gibson Street and West Ave, neither structure remains undersized at the 10-year event.

Table 5: Analysis of flows passed by each bridge under proposed conditions

Street Name	2-year Flow (cfs)	2-year Culvert Flow (cfs)	% Under Capacity
N Pearl	150	150	0
School	170	170	0
W Gibson	170	170	0
West	180	180	0
Chapin	200	200	0
Bristol	200	200	0
Clark	210	210	0
Parrish	210	210	0

Street Name	10-year Flow (cfs)	10-year Culvert Flow (cfs)	% Under Capacity
N Pearl	360	360	0
School	410	410	0
W Gibson	420	420	0
West	420	420	0
Chapin	450	410	9
Bristol	450	450	0
Clark	450	450	0
Parrish	460	460	0

Street Name	25-year Flow (cfs)	25-year Culvert Flow (cfs)	% Under Capacity
N Pearl	490	490	0
School	570	570	0
W Gibson	580	570	2
West	590	530	10
Chapin	630	490	22
Bristol	620	620	0
Clark	630	630	0
Parrish	630	630	0

Street Name	50- year Flow (cfs)	50- year Culvert Flow (cfs)	% Under Capacity
N Pearl	590	590	0
School	700	670	4
W Gibson	700	630	10
West	720	550	24
Chapin	780	560	28
Bristol	780	780	0
Clark	780	780	0
Parrish	790	790	0

Street Name	100-year Flow (cfs)	100-year Culvert Flow (cfs)	% Under Capacity
N Pearl	690	690	0
School	830	730	12
W Gibson	840	660	21
West	870	570	34
Chapin	980	630	36
Bristol	960	960	0
Clark	960	880	8
Parrish	980	930	5

Street Name	500-year Flow (cfs)	500-year Culvert Flow (cfs)	% Under Capacity
N Pearl	890	890	0
School	1170	830	29
W Gibson	1280	690	46
West	1420	570	60
Chapin	1570	780	50
Bristol	1500	1480	1
Clark	1510	910	40
Parrish	1570	1270	19

Chapin Street remains undersized at the 10-year event even though the 35 ft widened bridge does have more capacity than the 22 ft bridge. Not only is Chapin Street receiving a greater amount of flow from upstream, but the road is still being overtopped not at the bridge structure itself, but at a low point in the road profile.

When comparing the percent the structures are under capacity during existing and proposed conditions, the capacity for the School Drive bridge, West Gibson Street, and West Ave bridges are significantly improved for the 10-, 25-, and 50-year events, and moderately improved for the 100- and 500-year events (Table 6).

Table 6: Comparison of bridge opening percent undersized for existing and proposed conditions

Street Name	2-Year	
	Existing % Under Capacity	Proposed % Under Capacity
N Pearl	0	0
School	0	0
W Gibson	0	0
West	0	0
Chapin	0	0
Bristol	0	0
Clark	0	0
Parrish	0	0

Street Name	10-Year	
	Existing % Under Capacity	Proposed % Under Capacity
N Pearl	0	0
School	0	0
W Gibson	5	0
West	3	0
Chapin	10	9
Bristol	0	0
Clark	0	0
Parrish	0	0

Street Name	25-Year	
	Existing % Under Capacity	Proposed % Under Capacity
N Pearl	0	0
School	7	0
W Gibson	26	2
West	26	10
Chapin	21	22
Bristol	0	0
Clark	0	0
Parrish	0	0

Street Name	25-Year	
	Existing % Under Capacity	Proposed % Under Capacity
N Pearl	0	0
School	7	0
W Gibson	26	2
West	26	10
Chapin	21	22
Bristol	0	0
Clark	0	0
Parrish	0	0

Street Name	100-Year	
	Existing % Under Capacity	Proposed % Under Capacity
N Pearl	0	0
School	28	12
W Gibson	48	21
West	49	34
Chapin	36	36
Bristol	0	0
Clark	7	8
Parrish	4	5

Street Name	500-Year	
	Existing % Under Capacity	Proposed % Under Capacity
N Pearl	0	0
School	45	29
W Gibson	66	46
West	69	60
Chapin	54	50
Bristol	1	1
Clark	40	40
Parrish	19	19

In terms of water surface elevations, the improved capacity bridges are resulting in a maximum decrease in WSEL of about 1 foot upstream (US) of West Gibson Street. The matrix in Table 7 shows the reduction in WSEL achieved by the bridge modifications. A maximum decrease in WSEL of approximately 1 ft is observed during the 10-year storm, while the 100-year storm shows a maximum decrease of approximately 0.4 ft. Unfortunately, by widening the bridges and allowing more flow through downstream (DS), the modeling shows an increase in WSEL downstream of Chapin Street and at Bristol St. This rise continues further downstream to Clark and Parrish streets. Through modeling multiple different scenarios, it was found that this rise could be mitigated by installing a floodplain bench in conjunction with the higher capacity bridges.

Table 7: Reduction in water surface elevations due to Alternative 1

Address	Difference in Water Surface Elevation (ft)					
	2-Year	10-Year	25-year	50- year	100-year	500-year
School US	-0.28	-0.61	-0.54	-0.40	-0.34	-0.24
School DS	-0.26	-0.55	-0.45	-0.34	-0.26	-0.18
W Gibson US	-0.58	-1.01	-0.69	-0.48	-0.37	-0.20
W Gibson DS	-0.34	-0.42	-0.27	-0.30	-0.26	-0.21
West US	-0.15	-0.30	-0.25	-0.21	-0.17	-0.11
West DS	-0.09	-0.06	-0.07	-0.06	-0.05	-0.04
Chapin US	-0.13	-0.13	-0.23	-0.32	-0.37	-0.16
Chapin DS	0.02	0.10	0.04	0.02	0.03	0.02
Bristol US	0.01	0.18	0.09	0.01	0.02	0.00
Bristol DS	0.00	0.14	0.07	0.01	0.01	0.00

Grant opportunities for increasing the capacity of bridges include, but are not limited to, NYS Resilient Watershed Grant, NYS Green Resiliency Grants, NYS Water Quality Improvement Project (WQIP) Non-Agricultural Nonpoint Source Abatement and Control Grant Program, and NYS WQIP Aquatic Connectivity Restoration Grant Program. More information on these programs can be found in the Grant Opportunities Technical Memo in Appendix 2.

Bridgeless Scenario

Increasing the capacity of the bridges did not lower water surface elevations in the 100-year return interval more than 0.37 feet. Therefore, the undersized bridges are likely not the sole reason for the flooding. To further evaluate the effects of the bridges on flooding, a scenario was modeled where the bridges were removed completely, and Sucker Brook was allowed to flow freely through Canandaigua without the constriction from the bridges. If the bridges within the city were the only reason for the flooding, this scenario would show significant reductions in water surface elevation. In this bridgeless scenario, the water surface elevations were reduced by up to 0.51 ft in the 10-year storm and up to 0.85 ft in the 100-year storm. However, there are also increases in water surface elevation of up to 0.29 ft in the 100-year storm. See Table 8 for a comparison table of differences in water surface elevation for the Bridgeless Scenario.

Table 8: Reduction in WSELs due to removal of all bridges from N Pearl through Route 20

Address	Difference in Water Surface Elevation (ft)					
	2-Year	10-Year	25-year	50- year	100-year	500-year
School US	0.00	-0.39	-0.45	-0.43	-0.43	-0.34
School DS	-0.01	-0.19	-0.16	-0.11	-0.07	0.01
W Gibson US	-0.03	-0.46	-0.51	-0.46	-0.42	-0.28
W Gibson DS	0.00	0.10	0.21	0.20	0.29	0.45
West US	0.16	-0.11	-0.21	-0.21	-0.19	-0.16
West DS	0.00	0.04	0.03	0.04	0.04	-0.02
Chapin US	0.07	0.00	-0.11	-0.31	-0.51	-0.75
Chapin DS	0.00	0.06	-0.06	-0.08	-0.21	-0.75
Bristol US	0.13	0.02	-0.22	-0.55	-0.85	-1.49
Bristol DS	-0.01	0.05	0.01	-0.19	-0.39	-0.20

While the results of the Bridgeless Scenario showed a reduction in water surface elevation, the flooding is still widespread throughout Canandaigua. A comparison of the existing 100-year inundation area and the Bridgeless Scenario inundation area is shown below in Figure 8. The reduced inundation area that would be achieved if there were no bridges from North Pearl Street all the way down to the Canandaigua Lake inlet is shown in green, while the Existing Conditions inundation area is shown in blue. The amount of area recovered from flooding during this best-case scenario is minimal, with the most area recovered being at Clark Street, followed by between Clark and Bristol streets, and between Bristol and Chapin streets.

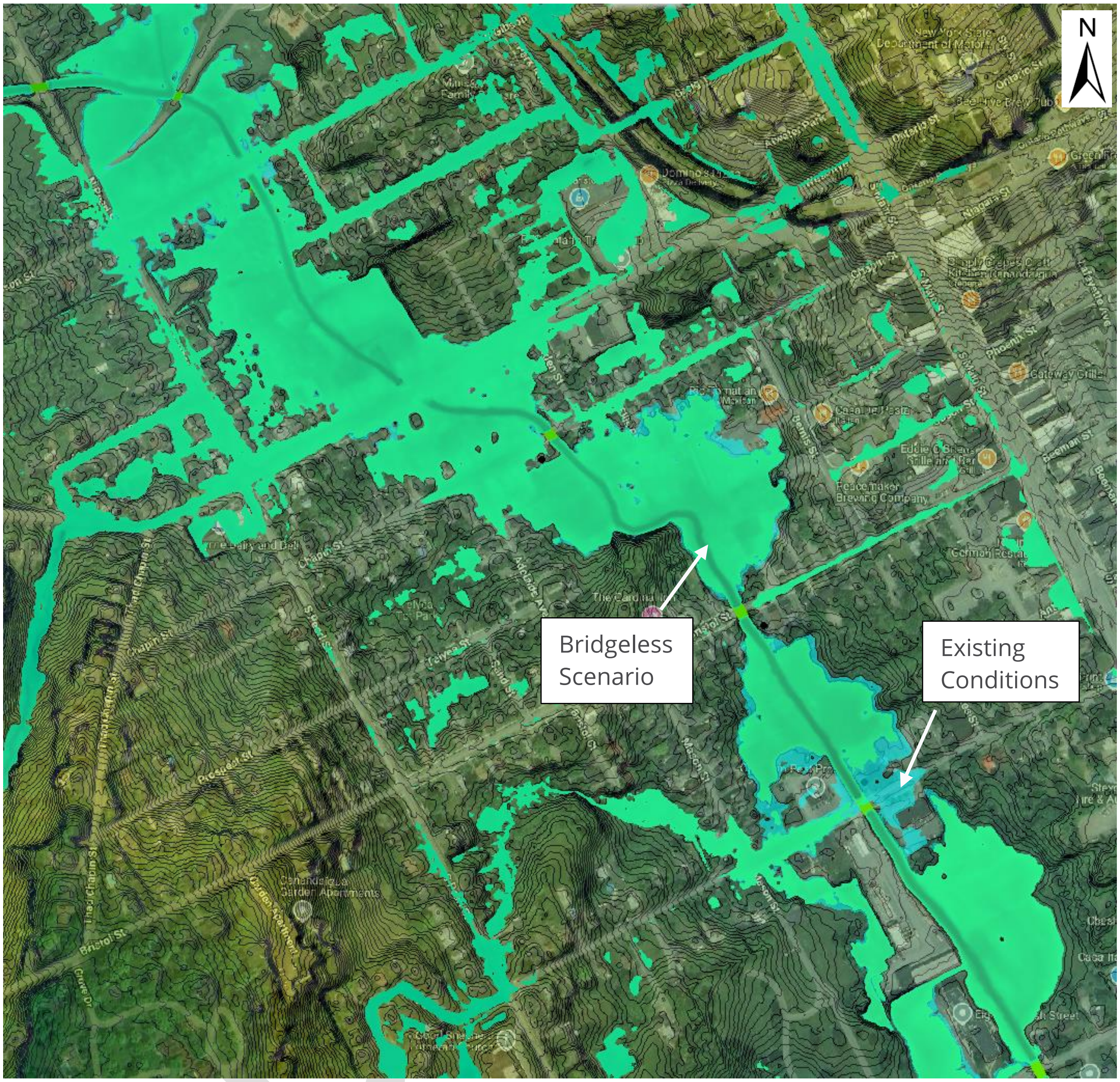


Figure 8: Comparison of 100-year inundation area with and without bridges

Critical Channel Reach Expansion Evaluation – Alternative 2

As an alternative to upsizing the bridges, Task 3 involved evaluating specific channel reaches for potential expansion. In this case, channel reach expansions were evaluated by using floodplain benches. The two locations that were analyzed to implement floodplain benches were between Chapin Street and Bristol Street, near Ellis Place (Alternative 2A), and between West Gibson Street and West Avenue (Alternative 2B).

Alternative 2A – Ellis Place Floodplain Bench

Alternative 2A proposes to alter approximately 700 feet of stream between Chapin and Bristol streets at the S turn in Sucker Brook. The right bank is proposed to be cut back 10 feet into the existing steep hillside. The left bank is proposed to be cut back 10 to 70 feet at an elevation of 0.5 to 1 foot above the normal water surface. **Figure** shows the existing conditions contours at the S curve near Ellis Place, while **Figure** shows the proposed benches on either side of the stream. The Manning's n values in the bench area were also raised to a value of 0.1 to account for a planted riparian buffer area. Discussions with landowners in this area are ongoing, and a solution that does not impact homeowners is under development. The dimensions of this bench and resulting WSEL reductions are subject to change as this alternative is developed further.

Figure 9: Existing conditions S curve

Figure 10: Proposed conditions S curve for Alternative 2A

The bench at Ellis Place results in a maximum WSEL decrease of approximately 0.8 ft during the 10-year storm, but a maximum decrease of about 0.4 ft is observed during the 100-year storm. Again, as with Alternative 1, more gains in terms of WSEL reduction are seen at the higher frequency storm events (Table 9).

Table 9: Reduction in water surface elevations due to Alternative 2A

Address	Difference in Water Surface Elevation (ft)					
	2-Year	10-Year	25-year	50- year	100-year	500-year
School US	-0.29	-0.60	-0.51	-0.38	-0.33	-0.22
School DS	-0.26	-0.54	-0.40	-0.30	-0.23	-0.16
W Gibson US	-0.41	-0.83	-0.57	-0.39	-0.31	-0.17
W Gibson DS	-0.23	-0.25	-0.10	-0.14	-0.10	-0.05
West US	-0.21	-0.35	-0.28	-0.22	-0.18	-0.11
West DS	-0.15	-0.13	-0.10	-0.08	-0.06	-0.05
Chapin US	-0.35	-0.29	-0.35	-0.41	-0.41	-0.18
Chapin DS	-0.34	-0.28	-0.24	-0.21	-0.16	-0.08
Bristol US	-0.07	0.04	-0.04	-0.11	-0.13	-0.09
Bristol DS	-0.13	-0.09	-0.15	-0.22	-0.22	-0.13

Alternative 2B – West Gibson to West Ave Floodplain Bench

Alternative 2B proposes to alter approximately 400 feet of stream between West Gibson Street and West Avenue. The right bank is proposed to be cut back 80 feet at an elevation of 0.5 to 1 foot above the normal water surface. **Figure** 11 shows the existing conditions contours at the proposed bench between West Gibson and West, while **Figure** shows the proposed bench on the right bank of Sucker Brook. The Manning's n values in the bench area were also raised to a value of 0.1 to account for a riparian buffer area. This alternative would potentially require land acquisition or agreement and concurrence from the current landowners.

Figure 11: Alternative 2B existing conditions

Figure 12: Alternative 2B proposed conditions

Alternative 2B results in a maximum WSEL decrease of 0.3 ft during the 10-year storm, but only a 0.2 ft decrease during the 100-year storm. As seen with the previous alternatives, the larger reductions in WSELs are observed during the higher frequency storm events (Table 10).

Table 10: Reduction in water surface elevations due to Alternative 2B

Address	Difference in Water Surface Elevation (ft)					
	2-Year	10-Year	25-year	50- year	100-year	500-year
School US	-0.09	-0.10	-0.03	-0.01	-0.01	0.00
School DS	-0.15	-0.16	-0.07	-0.04	-0.02	-0.02
W Gibson US	-0.30	-0.29	-0.12	-0.06	-0.04	-0.02
W Gibson DS	-0.34	-0.24	-0.17	-0.16	-0.04	-0.04
West US	-0.07	-0.05	-0.02	-0.02	-0.01	-0.01
West DS	-0.07	-0.06	-0.04	-0.03	-0.03	-0.01
Chapin US	-0.03	0.02	0.04	0.03	0.00	-0.02
Chapin DS	-0.03	-0.01	-0.10	-0.03	-0.06	-0.06
Bristol US	-0.08	-0.10	-0.11	-0.12	-0.12	-0.08
Bristol DS	-0.14	-0.20	-0.21	-0.23	-0.21	-0.13

Grant opportunities for floodplain benches include, but are not limited to, NYS Resilient Watershed Grant, NYS Water Quality Improvement Project (WQIP) Non-Agricultural Nonpoint Source Abatement and Control Grant Program, and NYS WQIP Fish and Wildlife Restoration and Enhancement Grant Program. More information on these programs can be found in the Grant Opportunities Technical Memo in Appendix 2.

School Drive Berm – Alternative 3

The School Drive Berm (Alternative 3) evaluates the effects of constructing a berm between the School Drive and West Gibson Street in conjunction with two floodplain benches on either side of Sucker Brook downstream of School Drive. Placing the berm on the downstream (south) side of School Drive protects houses on both sides of West Gibson Street by lowering the WSELs in this area. However, floodplain benches are required for this alternative because placing the berm in this location will back water up to the north and east and cause increased WSELs in those areas. Incorporating floodplain benches south of School Drive will reduce the amount that the WSELs will increase to the north and east of the berm.

Figure shows the existing conditions at Alternative 3, while **Figure** shows the proposed berm and benches. The berm is proposed to be approximately 540 linear feet (LF) long going from North Pearl Street to West Gibson Street, 4 ft high, with a top width of 10 ft, and side slopes of 2:1 (H:V). The left overbank (east) bench is proposed to be cut back 80 feet at an elevation of 0.5 to 1 foot above the normal water surface for a length of 170 ft along the stream. The right overbank (west) bench is proposed to be cut back 50 ft at an elevation of 0.5 to 1 foot above the normal water surface for a length of 160 ft along the stream.

The berm is effective at reducing WSELs its south side where the homes on West Gibson are, such that the homes are almost completely protected from the 10-year flood. Figure 15 shows how the Alternative 3 berm reduces the existing 10-year inundation area, signified by the transparent light blue, to the opaque blue area, which would be the 10-year flood with the berm in place.

Figure 13: Existing conditions contours at Alternative 3 location

Figure 14: Alternative 3 proposed conditions, showing berm and floodplain benches

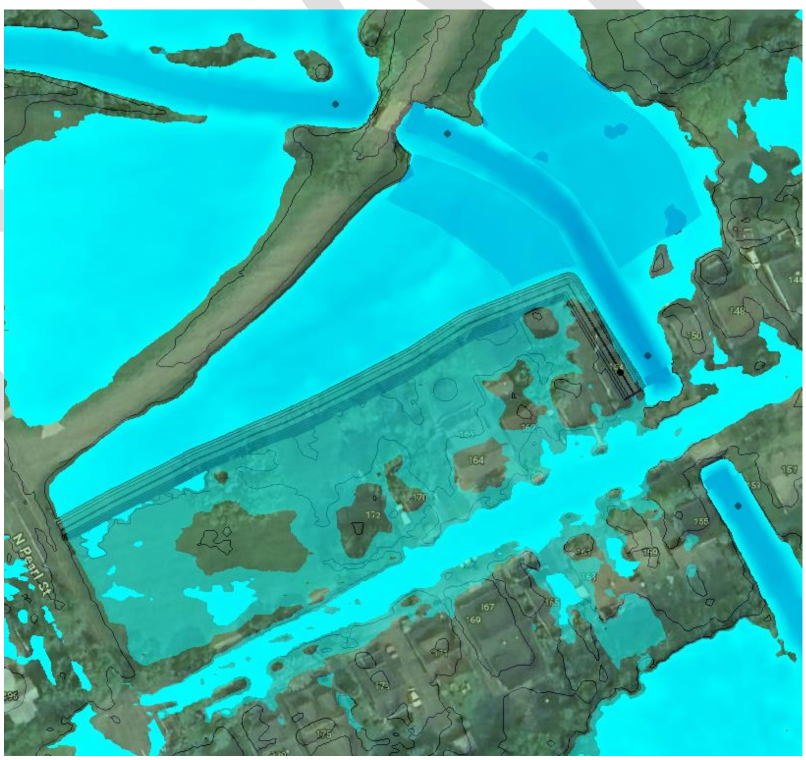


Figure 15: 10-year flood inundation area comparison of Existing Conditions to Alternative 3

Unfortunately, even with the two floodplain benches, WSELs are still increasing to the north and east of the berm at School Drive and West Gibson Street, especially at lower frequency storm events (Table 11). The maximum WSEL increase is about 0.5 ft during the 25-year storm and about 1 ft during the 500-year storm. While the berm would lower WSELs for the houses to the west of Sucker Brook on West Gibson, these increases could have serious impacts on homeowners to the east of Sucker Brook on West Gibson Street. For this reason, this alternative needs further examination. Potentially, increasing the size of the floodplain benches could be a solution to the WSEL increases.

Table 11: Reduction in WSELs due to Alternative 3

Address	Difference in Water Surface Elevation (ft)					
	2-Year	10-Year	25-year	50- year	100-year	500-year
School US	-0.16	0.02	0.24	0.34	0.41	0.49
School DS	-0.25	0.04	0.45	0.62	0.77	0.97
W Gibson US	0.02	0.04	0.40	0.54	0.64	0.78
W Gibson DS	-0.05	0.04	0.31	0.28	0.37	0.52
West US	-0.09	-0.06	-0.06	-0.05	-0.03	-0.01
West DS	-0.08	-0.06	-0.06	-0.06	-0.04	-0.01
Chapin US	-0.03	0.04	0.01	0.03	0.00	-0.03
Chapin DS	-0.04	0.00	-0.12	-0.03	-0.07	-0.08
Bristol US	-0.08	-0.08	-0.15	-0.13	-0.13	-0.10
Bristol DS	-0.15	-0.19	-0.24	-0.24	-0.23	-0.14

The berm could be constructed without the use of grant money. Should grants be utilized, opportunities for the construction of a berm include, but are not limited to, the FEMA Hazard Mitigation Grant Program (HMGP). More information on this program can be found in the Grant Opportunities Technical Memo in Appendix 2.

Combination Alternative

The Combination Alternative (Alternative 4) evaluates the effects of performing the work outlined in Alternative 1 and Alternative 2, by incorporating the increased capacity bridges and floodplain benches into a single model. This Alternative 4 provides a holistic view of the Sucker Brook floodplain area and the potential mitigation strategies that can be combined to provide the maximum amount of protection from each frequency storm to Canandaigua citizens.

Alternative 4 results in a maximum WSEL decrease of 1 ft during the 10-year storm, and a maximum decrease of 0.4 ft during the 100-year storm (Table 12). The reductions in WSELs for Combined Alternative still have the largest effect on the higher frequency storms, however, the reductions gained at the lower frequency storms are slightly improved. It is also important to note that there are no increases in WSEL for any return period anywhere in the watershed due to the Combination Alternative, save for a 0.03 ft rise upstream of Bristol Street in the 10-year model. This rise is negligible and does not impact any structures, as the flooding for this storm at this location is confined to the channel.

Table 12: Reduction in WSELs due to the Combination Alternative 4

Address	Difference in Water Surface Elevation (ft)					
	2-Year	10-Year	25-year	50- year	100-year	500-year
School US	-0.29	-0.62	-0.54	-0.39	-0.33	-0.23
School DS	-0.27	-0.57	-0.45	-0.33	-0.24	-0.15
W Gibson US	-0.56	-1.04	-0.72	-0.52	-0.38	-0.20
W Gibson DS	-0.53	-0.58	-0.37	-0.38	-0.29	-0.18
West US	-0.21	-0.35	-0.28	-0.22	-0.18	-0.11
West DS	-0.16	-0.13	-0.10	-0.08	-0.06	-0.05
Chapin US	-0.35	-0.30	-0.35	-0.40	-0.41	-0.18
Chapin DS	-0.34	-0.28	-0.24	-0.21	-0.15	-0.08
Bristol US	-0.08	0.03	-0.04	-0.11	-0.13	-0.10
Bristol DS	-0.14	-0.10	-0.15	-0.23	-0.22	-0.13

This goal of this alternative is to also be combined with the berm and bench at the School Drive in Alternative 3; however, additional modeling is required to understand how these two projects would work together.

Colliers Engineering & Design

Other Alternatives

Alternatives other than what were evaluated above include voluntary buyouts, relocating homes out of the 100-year flood area, elevating homes above the 100-year flood area, other individual mitigation strategies, and adding upstream detention. These alternatives were not included in the modelling but are discussed below.

Voluntary Buyouts

There are seven (7) homes within the FEMA Preliminary Floodway. These homes, being located in the floodway are identified by FEMA as being at the highest risk of incurring flood damages. The primary goal of a buyout program is to get the people in the highest risk areas out of harm's way through the purchase of their property by the City. However, participation in a property buyout must be voluntary. No one will be removed from their property against their will.

If certain property owners are interested in a buyout from the City, their property will not be resold, the existing structure would be demolished, and the area would remain as open space for floodwaters. Potential uses for the buyout area could include additional channel or bypass channel capacity for Sucker Brook, a floodplain bench, riparian area, or park space.

Grant opportunities for voluntary buyouts include, but are not limited to, FEMA Flood Mitigation Assistance (FMA), FEMA FMA Swift Current, and the NYS Resilient Watershed Grant. More information on these programs can be found in the Grant Opportunities Technical Memo in Appendix 2.

Voluntary Relocation of Homes

There may be opportunities to voluntarily relocate homes in the Sucker Brook watershed to remove them from the SFHA or at least remove them from the floodway. It would involve the physical relocation of the existing structure to a new parcel outside of a hazard prone area, and the acquisition of the old parcel. Relocating homes is costly, but moving or removing structures from the floodplain is the most effective way to prevent flood damages. As with buyouts, participation in this program must be voluntary. No one will have their home relocated against their will.

The City of Schenectady, New York, has evaluated relocating 21 structures in the historic Stockade District to vacant land outside the 500-year flood zone. The homes would be moved onto concrete slabs but maintain their current layouts. Besides the relocation of the structures, no elevation to the existing structures is proposed. The City of Schenectady is still evaluating this option.

Grant opportunities for voluntary home relocation include, but are not limited to, FEMA Flood Mitigation Assistance (FMA), and FEMA FMA Swift Current. More information on these loan programs can be found in the Grant Opportunities Technical Memo in Appendix 2.

Home Elevation

A common method of flood mitigation retrofits is home elevation. According to FEMA's elevation guidelines, if the first floor elevation (FFE) of a home is below the base flood elevation (BFE), or 100-year flood elevation, then the first floor should be elevated to the BFE plus 2 feet of freeboard. In most elevation projects, the existing home is separated from its foundation on hydraulic jacks and temporarily supported with timber cribbing. A new foundation is then constructed at the appropriate elevation, and the house is lowered back down onto it. To bring the home into compliance with code, the basement would be filled to the elevation of the exterior grade and flood vents installed for the remaining space below the first floor. This way, during flooding only the foundation is exposed to water, and the living area is not impacted.

Elevating homes, like relocation, is costly, but moving or removing structures from the floodplain is the most effective way to prevent flood damages. Grant opportunities for home elevation include, but are not limited to, FEMA Flood Mitigation Assistance (FMA), FEMA FMA Swift Current, and FEMA Hazard Mitigation Grant Program (HMGP). More information on these programs can be found in the Grant Opportunities Technical Memo in Appendix 2.

Individual Mitigation Strategies

There are certain mitigation strategies that individual homeowners can undertake to protect themselves from flooding. Residential structures built on crawlspaces should already be equipped with flood vents, or openings, to equalize pressure on either side of the foundation walls and protect the foundation from caving in. FEMA Technical Bulletin 1 outlines the Requirements for Flood Openings in Foundation Walls and Walls of Enclosures. Flood vents are a relatively simple to install and a cheap mitigation strategy when compared to the cost of a foundation repair.

For residential structures built with basements, the elevation of utilities such as water heaters, furnaces, and electrical panels from the basements to the first floor may save these utilities and mitigate much of the reconstruction costs after a flood event. In addition, while these structures would likely be existing non-conforming and not in violation of the Local Law for Flood Damage Prevention, for them to brought into compliance with code, the basement should be filled to the elevation of the exterior grade and flood vents should be installed for the remaining space below the first floor. Additionally, if the FFE is below the BFE, or 100-year flood elevation, then the first floor should be elevated to the BFE plus 2 feet of freeboard (see previous section on elevation for more information).

Commercial structures built in the SFHA should be dry floodproofed up to an elevation of the BFE plus 2 feet of freeboard. FEMA Technical Bulletin 3 outlines the Requirements for the Design and Certification of Dry Floodproofed Non-Residential and Mixed-Use Buildings.

While these mitigation strategies are for individual property owners, there may be grants available to assist property owners throughout the community. Grant opportunities for the mentioned mitigation strategies include, but are not limited to, FEMA Flood Mitigation Assistance (FMA), FEMA FMA Swift Current, FEMA Hazard Mitigation Grant Program (HMGP), and NYS Homes and Community Renewal - Resilient Retrofit Loan Program. More information on these programs can be found in the Grant Opportunities Technical Memo in Appendix 2.

Upstream Detention/Wetland Restoration

Multiple detention projects have been completed by the town upstream of where Sucker Brook flows though the city. Additional projects are planned, and their effects can be quickly evaluated by adding them to the Hydraulic Model. An example of one of these completed projects is south of 5&20 in the Town of Canandaigua (Figure 16).

The 5&20 detention project not only enhanced an existing wetland and created and emergent marsh, but it also attenuated the 100-year storm flow by 73 cfs, reducing flows from 439 cfs upstream of the project to 366 cfs downstream of the project. See Figure 17 for a comparison chart of the 100-year storm hydrographs upstream and downstream of the project.

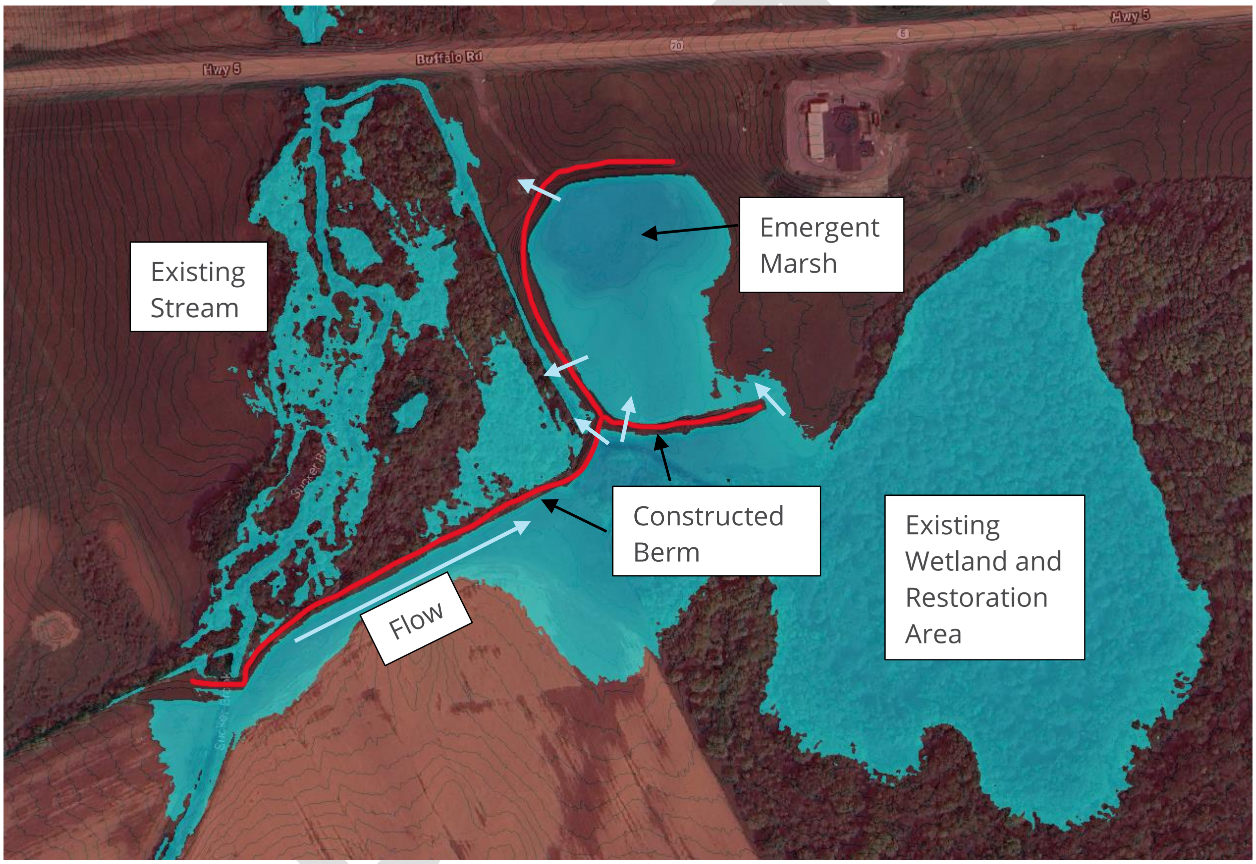


Figure 16: 5&20 detention project with 100-year inundation area

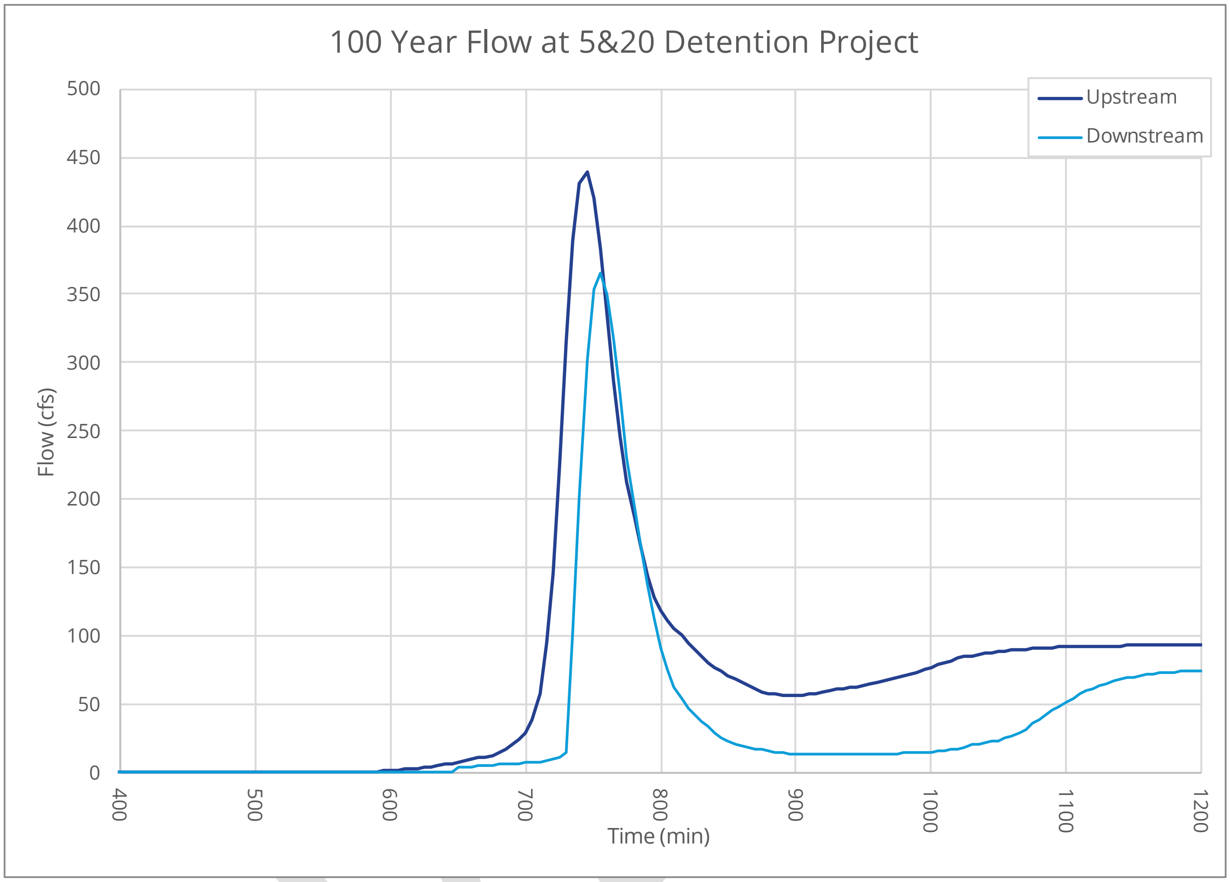


Figure 17: 100-year hydrographs upstream and downstream of the 5&20 detention project

One of the proposed detention projects located on the East Branch of Sucker Brook in the open space near Canandaigua Winery (Figure 18). This potential storage gained in this area would be for a tributary (East Branch), not the main stem of Sucker Brook. However, this tributary still contributes a significant amount of flow (approximately 175 cfs) to Sucker Brook. By adding a storage area in this area, floodwaters could be detained and slowed down and released at a slower rate to reduce the effect of flooding downstream. Further analysis still needs to be done to understand exactly how much storage projects such as these would mitigate flooding downstream.

Figure 18: Potential upstream storage project near Canandaigua Winery

Grant opportunities for upstream detention and/or wetland restoration include, but are not limited to, NYS Resilient Watershed Grant, NYS Green Innovation Grant Program, NYS Green Resiliency Grants, NYS Water Quality Improvement Project (WQIP) Non-Agricultural Nonpoint Source Abatement and Control Grant Program, and NYS WQIP Fish and Wildlife Habitat Restoration and Enhancement Grant Program. More information on these programs can be found in the Grant Opportunities Technical Memo in Appendix 2.

Discussion

The bridges along Sucker Brook within the City of Canandaigua begin to be under capacity starting with the 10-year storm (see Table 3). Alternative 1 evaluated increasing the size of four of these bridges and achieved reductions in water surface elevations of up to 1 ft in the 10-year storm and up to 0.37 ft for the 100-year storm. Alternative 2 evaluated the effects of two different floodplain benches, and reduced water surface elevations by up to 0.83 ft in the 10-year storm and up to 0.41 ft in the 100-year storm. Alternative 3 evaluated the effects of adding a berm between West Gibson and the School Drive, and reduced water surface elevations outside the berm by up to 0.06 ft in the 10-year storm and up to 0.23 ft in the 100-year storm. The combination of Alternative 1 and 2 reduced water surface elevations by up to 1 ft in the 10-year storm and up to 0.41 ft in the 100-year storm. These reductions are summarized below in Table 13.

Table 13: Summary of WSEL reductions for the 10- and 100-year storms in each alternative

Address	Difference in Water Surface Elevation (ft)									
	Alternative 1		Alternative 2a		Alternative 2b		Alternative 3		Alternative 1+2	
	10-Year	100-year	10-Year	100-year	10-Year	100-year	10-Year	100-year	10-Year	100-year
School US	-0.61	-0.34	-0.08	-0.01	-0.60	-0.33	0.02	0.41	-0.62	-0.33
School DS	-0.55	-0.26	-0.13	-0.02	-0.54	-0.23	0.04	0.77	-0.57	-0.24
W Gibson US	-1.01	-0.37	-0.14	-0.03	-0.83	-0.31	0.04	0.64	-1.04	-0.38
W Gibson DS	-0.42	-0.26	0.01	0.02	-0.25	-0.10	0.04	0.37	-0.58	-0.29
West US	-0.30	-0.17	-0.05	-0.01	-0.35	-0.18	-0.06	-0.03	-0.35	-0.18
West DS	-0.06	-0.05	-0.08	-0.03	-0.13	-0.06	-0.06	-0.04	-0.13	-0.06
Chapin US	-0.13	-0.37	-0.20	-0.08	-0.29	-0.41	0.04	0.00	-0.30	-0.41
Chapin DS	0.10	0.03	-0.39	-0.18	-0.28	-0.16	0.00	-0.07	-0.28	-0.15
Bristol US	0.18	0.02	-0.13	-0.14	0.04	-0.13	-0.08	-0.13	0.03	-0.13
Bristol DS	0.14	0.01	-0.23	-0.22	-0.09	-0.22	-0.19	-0.23	-0.10	-0.22

Based on the above reductions in water surface elevations and the results of the Bridgeless Scenario, there are a multitude of factors contributing to flooding in Canandaigua, and it cannot be solely attributed to undersized bridges. The flooding cannot therefore be addressed only with upsizing bridges, and other alternatives, such as those discussed in Alternative 2 or 3, as well as the alternatives of voluntary buyouts, relocating homes out of the 100-year flood area, floodproofing, and adding upstream detention should be considered.

Appendix 1

Hydrologic Analysis

120 Madison Street Tower 2 Suite 500 Syracuse New York 13202
Main: 877 627 3772

Colliers
Engineering & Design

Memorandum

To:	City of Canandaigua
From:	Geoff Golick, EIT, CFM; Liz Isenstein, PE
Date:	May 2, 2025
Subject:	Sucker Brook Sub-watershed – Hydrologic Analysis
Project No.:	24006209G

Background

Colliers Engineering & Design (CED) has been retained to provide professional services including an updated hydrologic study of the Sucker Brook subwatershed in the City and Town of Canandaigua, Ontario County, New York. The overall Sucker Brook watershed (Figure 1) consists of approximately 8.7 square miles of various land uses ranging from high density developed to cultivated crops.

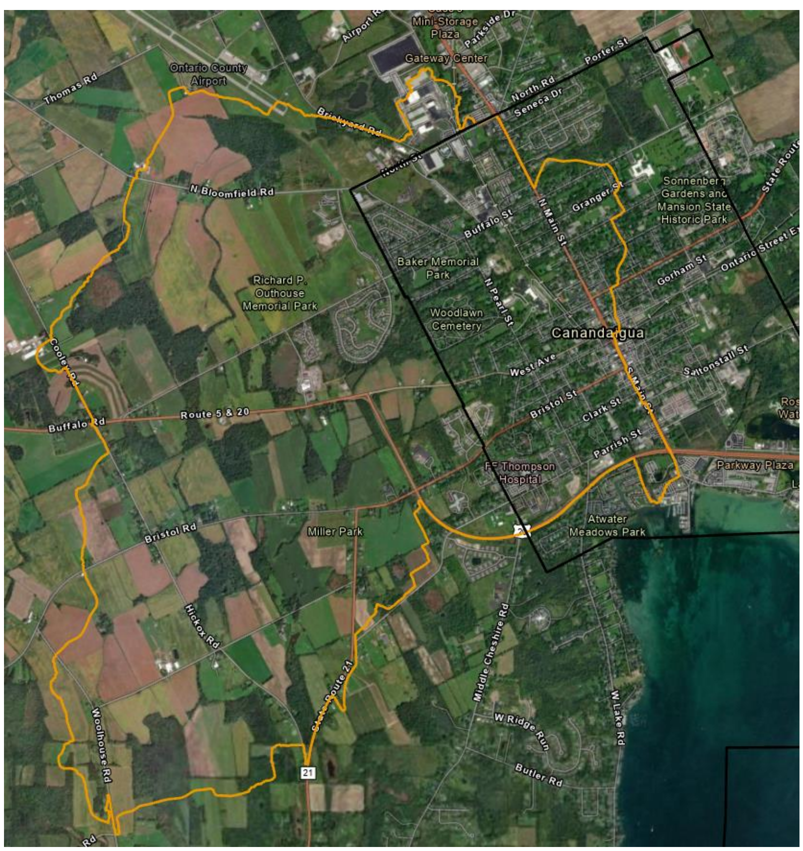


Figure 1: Sucker Brook subwatershed overlaid on aerial imagery

Colliers Engineering & Design

Foundational Datasets and Study

A comprehensive engineering study of the Sucker Brook watershed was completed in 2006 by the MRB Group. The study evaluated peak flow rates for various storm intensities from 55 subbasins of Sucker Brook along with providing peak flow rates at 42 structures and 39 channel reaches. This study served as the basis for the hydrologic analysis performed by CED.

A 1-meter digital elevation model (DEM), collected in 2019 was obtained from the Discover GIS Data NY download site. This was used as the terrain for both the hydrologic and hydraulic analyses.

A land cover raster was obtained from the National Land Cover Database (NLCD) MRLC Viewer. Manual edits were made to the polygons to account for known drainage improvement projects within the Sucker Brook subwatershed. The land cover polygons were converted to Manning's n values based on the typical published values for each cover type and used for both the hydrologic and hydraulic analyses.

The Natural Resources Conservation Service (NRCS) Soil Survey was used to obtain Hydrologic Soil Groups (HSGs) for the Sucker Brook watershed area.

Hydrologic Analysis Methodology

The previous MRB study split the Sucker Brook watershed into 55 subbasins using TR-20 as the transform method. The TR-20 methodology is inherently conservative (and outdated) and tends to provide a larger peak value for any given runoff, and each time a main watershed is broken into sub-watersheds, that conservatism tends to be compounded within the model. Additionally, the routing of each subbasin after concentrated flow is achieved can be highly varied and therefore can compound the conservatism further. For a total watershed that is approximately nine (9) square miles, using 55 sub-watersheds is too many break points and will over-predict flows. The goal of the analysis is to be conservative, but also as accurate as possible.

The CED delineation points were only placed either at bridge or culvert crossings, or at the confluence of tributaries. Draft subbasin delineation points were decided based on if the culvert or reach had been previously identified as critical either by MRB or the City of Canandaigua. CED also referenced the preliminary Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) to identify culverts that showed flooding backed up behind them (Figure 2). Once the draft delineation points were identified, CED met with the City of Canandaigua to finalize the points. Ultimately, 25 delineation points were chosen to analyze.

To calculate flows for subbasins in the Sucker Brook watershed, CED created a rainfall-runoff model using GeoHECHMS (v1.3.0.2798) and HEC-HMS (v4.9). Two different software packages were used because GeoHECHMS has capabilities that are not present in HEC-HMS such as automatic delineation of watersheds and longest flow paths. GeoHECHMS also can automatically load in NLCD and NRCS Soil Survey data. However, HEC-HMS is the industry standard and performs better when actually running the hydrologic simulation. For this reason, the preparatory work of setting up the hydrologic model was completed in GeoHECHMS and was then exported to HEC-HMS to run the analysis.

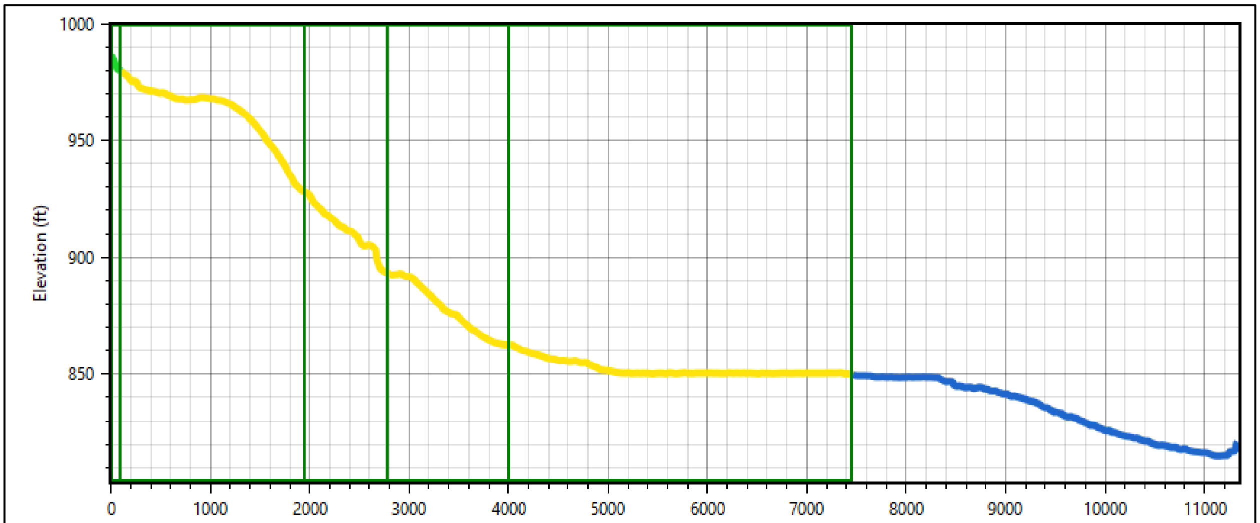
Colliers
Engineering & Design

Figure 2: Preliminary FIRM showing flooding around Buffalo St, Outhouse Rd, and N Bloomfield Rd

The delineation points were placed in the GeoHECHMS model. With the delineation points defined, the software utilized the underlying DEM to automatically delineate the 25 subbasins. It was necessary to manually adjust the automatic subbasin boundaries to account for flow through drainage ditches, under roadways, and in culverts and storm sewer systems. The subbasins were designated numbers 1 through 25 (Figure 3).

Figure 3: Map of the 25 subbasins

The longest flow paths for each subbasin were also automatically rendered using the GeoHECHMS software. The longest flow paths also had to be manually adjusted to account for flow through culverts, around houses, and along roadways. The sheet flow segments for the longest flow paths were set to 100 ft. The surface roughness type for shallow concentrated flow was adjusted as appropriate based on the aerial imagery. Surface contours were generated from the DEM and were used to determine at what point channel flow should begin. Additional shallow concentrated flow and channel flow segments were added where changes in slope and/or surface roughness occurred (Figure 4). With the longest flow paths created, the lag time and time of concentration (TOC) could then be calculated.



Define SCS TR-55 TOC Data [6 Segments]

☑ Maintain total flow length (adjacent segments will automatically adjust their lengths) Edit TOC Segments

TOC Segment	Runoff Flow Type	Flow Length (ft)	Slope (ft/ft)	Hydraulic Radius (ft)	Surface Roughness/Type	TOC (minutes)
1	Sheet Flow	100.00	0.06622		0.4000	16.15
2	Shallow Concentrated Flow	1853.98	0.02803		Short Grass	26.37
3	Shallow Concentrated Flow	844.09	0.04146		Forest Without Underbush	13.82
4	Shallow Concentrated Flow	1214.85	0.02491		Short Grass	18.33
5	Shallow Concentrated Flow	3448.66	0.00369		Forest Without Underbush	189.24
6	Channel Flow	3870.79	0.00741	0.45	0.0450	38.54

Figure 4: Exhibit showing the various segments a longest flow path

Weighted curve numbers (CNs) were calculated in GeoHECHMS for each subbasin using the edited land use polygons and the HSGs. Table 1 shows the hydrologic parameters, CN and lag time, that were used to calculate the hydrographs for each subbasin.

Table 1: Subbasin parameters

Subbasin No.	Curve Number	Lag Time (min)
Sub-1	79.48	47.53
Sub-2	72.48	44.41
Sub-3	74.81	31.71
Sub-4	78.07	58.68
Sub-5	83.41	31.04
Sub-6	83.30	36.96
Sub-7	87.59	14.06
Sub-8	85.01	27.80
Sub-9	76.17	62.84
Sub-10	79.09	152.54
Sub-11	80.05	74.99
Sub-12	78.25	181.47
Sub-13	76.34	89.33
Sub-14	88.51	24.27
Sub-15	82.39	45.38
Sub-16	86.31	40.76
Sub-17	72.44	39.82
Sub-18	80.61	48.64
Sub-19	83.56	31.51
Sub-20	74.64	175.17
Sub-21	87.11	43.25
Sub-22	84.84	28.15
Sub-23	74.37	28.87
Sub-24	72.00	24.41
Sub-25	78.43	44.43

The National Oceanic and Atmospheric Administration (NOAA) Atlas 14 precipitation data was used to develop meteorological models (hyetographs) for the 2-, 10-, 25-, 50-, 100- and 500-year storms using a 24-hour storm duration (Table 2) and Type II Soil Conservation Service (SCS) storm distribution. The control specifications were set so that the model would simulate 48 hours, completing a full day after the end of the rainfall to ensure the peak of the hydrograph is captured.

Table 2: Atlas 14 precipitation values

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.268** (0.211-0.337)	**0.326** (0.256-0.411)	**0.421** (0.330-0.532)	**0.500** (0.389-0.635)	**0.608** (0.458-0.807)	**0.689** (0.510-0.933)	**0.775** (0.556-1.09)	**0.873** (0.590-1.25)	**1.02** (0.659-1.50)	**1.14** (0.719-1.71)
10-min	**0.379** (0.299-0.478)	**0.461** (0.363-0.582)	**0.595** (0.468-0.753)	**0.707** (0.551-0.899)	**0.861** (0.649-1.14)	**0.976** (0.720-1.32)	**1.10** (0.787-1.54)	**1.24** (0.836-1.77)	**1.44** (0.935-2.13)	**1.61** (1.02-2.42)
15-min	**0.446** (0.352-0.562)	**0.543** (0.427-0.685)	**0.701** (0.550-0.887)	**0.832** (0.649-1.06)	**1.01** (0.764-1.35)	**1.15** (0.848-1.56)	**1.29** (0.926-1.82)	**1.46** (0.984-2.08)	**1.70** (1.10-2.50)	**1.89** (1.20-2.85)
30-min	**0.605** (0.477-0.763)	**0.737** (0.580-0.930)	**0.952** (0.747-1.20)	**1.13** (0.881-1.44)	**1.38** (1.04-1.83)	**1.56** (1.15-2.12)	**1.76** (1.26-2.47)	**1.98** (1.34-2.83)	**2.30** (1.49-3.40)	**2.57** (1.63-3.87)
60-min	**0.765** (0.603-0.964)	**0.931** (0.733-1.17)	**1.20** (0.944-1.52)	**1.43** (1.11-1.82)	**1.74** (1.31-2.31)	**1.97** (1.46-2.67)	**2.22** (1.59-3.12)	**2.50** (1.69-3.57)	**2.91** (1.89-4.30)	**3.25** (2.06-4.89)
2-hr	**0.941** (0.746-1.18)	**1.14** (0.902-1.43)	**1.46** (1.15-1.84)	**1.73** (1.36-2.18)	**2.10** (1.59-2.76)	**2.38** (1.76-3.19)	**2.67** (1.92-3.70)	**2.99** (2.03-4.23)	**3.45** (2.25-5.05)	**3.83** (2.44-5.70)
3-hr	**1.06** (0.841-1.32)	**1.27** (1.01-1.59)	**1.62** (1.29-2.03)	**1.92** (1.51-2.41)	**2.32** (1.76-3.04)	**2.62** (1.95-3.50)	**2.94** (2.12-4.05)	**3.29** (2.24-4.63)	**3.78** (2.48-5.49)	**4.18** (2.67-6.18)
6-hr	**1.28** (1.03-1.59)	**1.53** (1.22-1.90)	**1.94** (1.54-2.41)	**2.27** (1.80-2.84)	**2.74** (2.09-3.55)	**3.09** (2.30-4.07)	**3.45** (2.49-4.70)	**3.84** (2.64-5.35)	**4.39** (2.89-6.31)	**4.83** (3.10-7.07)
12-hr	**1.55** (1.25-1.91)	**1.84** (1.48-2.26)	**2.30** (1.84-2.84)	**2.68** (2.14-3.33)	**3.21** (2.47-4.13)	**3.61** (2.72-4.73)	**4.03** (2.93-5.43)	**4.48** (3.09-6.18)	**5.11** (3.39-7.27)	**5.62** (3.63-8.13)
24-hr	**1.84** (1.50-2.25)	**2.17** (1.76-2.65)	**2.70** (2.18-3.32)	**3.15** (2.52-3.88)	**3.76** (2.91-4.80)	**4.22** (3.20-5.48)	**4.70** (3.44-6.30)	**5.23** (3.63-7.14)	**5.99** (3.99-8.42)	**6.60** (4.28-9.44)
2-day	**2.16** (1.76-2.62)	**2.54** (2.07-3.08)	**3.16** (2.57-3.85)	**3.68** (2.97-4.50)	**4.39** (3.42-5.56)	**4.92** (3.76-6.35)	**5.49** (4.05-7.30)	**6.12** (4.27-8.27)	**7.04** (4.71-9.78)	**7.79** (5.08-11.0)
3-day	**2.39** (1.96-2.88)	**2.80** (2.29-3.39)	**3.48** (2.84-4.22)	**4.04** (3.27-4.92)	**4.81** (3.77-6.07)	**5.39** (4.13-6.92)	**6.00** (4.45-7.95)	**6.70** (4.69-9.00)	**7.71** (5.17-10.6)	**8.54** (5.59-12.0)
4-day	**2.58** (2.12-3.11)	**3.02** (2.48-3.64)	**3.74** (3.05-4.52)	**4.33** (3.52-5.26)	**5.15** (4.04-6.47)	**5.76** (4.42-7.37)	**6.41** (4.76-8.45)	**7.14** (5.01-9.55)	**8.21** (5.52-11.3)	**9.09** (5.96-12.7)
7-day	**3.08** (2.55-3.70)	**3.57** (2.95-4.28)	**4.37** (3.59-5.25)	**5.03** (4.11-6.08)	**5.95** (4.69-7.42)	**6.63** (5.11-8.41)	**7.35** (5.48-9.59)	**8.16** (5.75-10.8)	**9.31** (6.29-12.7)	**10.2** (6.75-14.2)
10-day	**3.57** (2.95-4.26)	**4.09** (3.38-4.89)	**4.95** (4.08-5.93)	**5.66** (4.64-6.81)	**6.64** (5.25-8.24)	**7.39** (5.70-9.30)	**8.16** (6.09-10.6)	**9.00** (6.37-11.9)	**10.2** (6.91-13.8)	**11.1** (7.36-15.3)
20-day	**5.06** (4.22-6.00)	**5.67** (4.72-6.73)	**6.67** (5.54-7.93)	**7.50** (6.19-8.96)	**8.65** (6.87-10.6)	**9.53** (7.39-11.8)	**10.4** (7.78-13.2)	**11.3** (8.07-14.8)	**12.5** (8.57-16.8)	**13.5** (8.95-18.3)
30-day	**6.33** (5.30-7.47)	**7.01** (5.86-8.28)	**8.11** (6.76-9.60)	**9.03** (7.47-10.7)	**10.3** (8.20-12.5)	**11.3** (8.75-13.9)	**12.2** (9.14-15.4)	**13.2** (9.43-17.1)	**14.4** (9.88-19.1)	**15.3** (10.2-20.6)
45-day	**7.94** (6.67-9.34)	**8.69** (7.29-10.2)	**9.91** (8.28-11.7)	**10.9** (9.08-12.9)	**12.3** (9.85-14.9)	**13.4** (10.4-16.4)	**14.5** (10.8-18.1)	**15.5** (11.1-19.9)	**16.7** (11.5-22.0)	**17.5** (11.7-23.5)
60-day	**9.31** (7.84-10.9)	**10.1** (8.51-11.9)	**11.4** (9.58-13.4)	**12.5** (10.4-14.8)	**14.0** (11.2-16.9)	**15.2** (11.9-18.5)	**16.3** (12.2-20.2)	**17.3** (12.5-22.2)	**18.6** (12.8-24.4)	**19.4** (13.0-25.8)

The GeoHECHMS model was exported to HEC-HMS and the various storm frequencies were ran in HEC-HMS using the SCS Unit Hydrograph transform method with a standard peak rate factor (PRF) of 484. The peak flow results of the standard PRF SCS Unit Hydrograph for the 25 subbasins were used as the inflows in the hydraulic analysis.

Appendix 2

Grant Technical Memo

Colliers
Engineering & Design

To: City of Canandaigua

From: Colliers Engineering & Design

Date: April 25, 2025

Re: Grant Opportunities

Dear Mr. Kevin Olvany:

Colliers Engineering & Design (CED) has prepared this technical memo detailing the funding opportunities currently available and future grant opportunities anticipated this year for flood mitigation, culvert replacement, floodplain bench/natural channel design, nature trials/walkways and floodproofing/home buyout programs.

The following grants are currently accepting applications:

Grant Name: **NYS Resilient Watershed Grant (RWG)**

Funding Entity: NYSDOS

Timeline: Deadline June 6th, 2025 @ 4pm

Funding Cap: $10,000,000.00

Match Requirement: 10%

Type: Planning and Construction

Grant Details: Aims to implement projects that enhance community resilience by promoting flood risk reduction, ice jam reduction, and restoration, while supporting healthy riparian habitats and improving the water quality.

Eligible Projects: Floodplain restoration, creation and/or reconnection to stream, wetland creation and/or restoration, berm removal, dam removal, stream culvert replacement and right sizing, culver bridge and appurtenant structures; streambank, stream channel, or shoreline restoration and/or stabilized establishment of riparian buffers; stream daylighting; acquisition of land.

Website: Flood Recovery And Resilience - NYSDEC

Grant Name: **Hazard Mitigation Grant Program (HMGP)**

Funding Entity: FEMA

Timeline: May 31, 2025

Funding Cap: $35.3 billion
Match Requirement: 25%

Type: Planning and Construction

Grant Details:

Planning & Enforcement
• Developing and adopting hazard mitigation plans, which are required for state, local, tribal and territorial governments to receive funding for their hazard mitigation projects.
• Acquisition of hazard prone homes and businesses which enable owners to relocate to safer areas (acquisition).
• Post-disaster code enforcement.

Flood Protection
• Protecting homes and businesses with permanent barriers to prevent floodwater from entering (levees, floodwalls, floodproofing).
• Elevating structures above known flood levels to prevent and reduce losses (elevation).
• Reconstructing a damaged dwelling on an elevated foundation to prevent and reduce future flood losses.
• Drainage improvement projects to reduce flooding (flood risk reduction projects).
Retrofitting
• Structural retrofits to make a building more resistant to floods, earthquakes, wind, wildfire and other natural hazards.
• Retrofits to utilities and other infrastructure to enhance resistance to natural hazards (utility retrofits).

Construction
• Construction of safe rooms for both communities and individual residences in areas prone to hurricane and tornado activity.
• Slope stabilization projects to prevent and reduce losses to structures.

Eligible Projects: Planning and enforcement, flood protection, construction.

Website: Flood Mitigation Assistance Grant Program | FEMA.gov

The NYSDEC Water Quality Improvement Project (WQIP) grant program will be released in April/May. There are application limits:

- Applicants may only apply for one project type per individual application.
- Only one application may be submitted per project per round.
- Applicants are limited to five applications per round.
- Applicants that have received funding in a previous round will not receive additional funding in this or a future round for the same scope of work. However, the WQIP program will fund distinct phases or different activities and costs or a project in consecutive rounds of funding if the applicant sufficiently describes how the planned scope of work is drastically different from the previous scope of work.

Grants available in the next few months:

Grant Name**: Water Quality Improvement Project (WQIP) – Non-Agricultural Nonpoint Source Abatement and Control**

Funding Entity: NYSDEC

Timeline: Releasing in April/May 2025

Funding Cap: $100,000 to $10,000,000 depending on the project subtype and population.

- Green Infrastructure Practices $2,000,000/$10,000,000
- Streambank/Shoreline Stabilization $1,000,000
- Riparian Buffers $100,000
- Stream Culvert Repair and Replacement $1,000,000
- Non-point Source Program $4,000,000

Match Requirement: 25% of award amount

Type: Planning and Construction

Grant Details: Funding is available for non-agricultural nonpoint source projects or programs that improve a documented water quality impairment, promote flood risk reduction, enhance flood and climate resiliency, and restoration or that protect a drinking water source.

Eligible Projects:
Green Infrastructure Practices:

- Projects to address combined sewer overflows, reduce a pollutant impacting a waterbody or address a regional water quality issue; provide resiliency to impacts from climate change; or reduce localized flooding; or projects to install green infrastructure practices designed to capture and remove the pollutant contributing to a water quality impairment.

Streambank/Shoreline Stabilization:

- Projects to reduce sedimentation of waterbodies caused by eroding streambanks, shorelines, and/or to filter surface runoff with riparian buffer vegetation.

Riparian Buffers

- Projects to replant vegetation within the riparian zone of waterbodies to filter nutrients and sediment, prevent streambank/shoreline erosion, reduce thermal impacts to the waterbodies and increase flood resiliency.

Stream Culvert Repair and Replacement

- Projects to reduce erosion, mitigate flooding and the impacts to climate change, and protect surrounding infrastructure caused by failing or inadequately sized stream culvert through culvert repair or replacement.

Nonpoint Source Program

- Projects to implement particular nonpoint source BMPs within a defined geographic area. Geographic areas include, but are not limited to: counties, watersheds, municipalities, or sanitary sewer overflow (SSO) areas.

Website: WQIP 2024 Program Overview

Grant Name: **Water Quality Improvement Project (WQIP) – Aquatic Connectivity Restoration**

Funding Entity: NYSDEC

Timeline: Releasing in April/May 2025

Funding Cap: $1,000,000

Match Requirement: 25% of award amount

Type: Planning and Construction

Grant Details: Projects that improve aquatic habitat connectivity at road/stream crossings or dams and may promote flood risk reduction and enhance flood and climate resiliency.

Eligible Projects: Upgrade and replacement of road stream crossing structures (culverts and bridges) to a larger size and appropriate design to increase the ecological connectivity and hydraulic capacity; remove or breach of stream barriers such as dams or weirs that limit aquatic connectivity or directly contribute to flooding and meet the natural resource management goals for the area. Projects that do not meet resource management goals, including those that would have a negative impact on native species, may not be found.

Website: WQIP 2024 Program Overview

Grant Name: **Water Quality Improvement Project (WQIP) – Fish and Wildlife Habitat Restoration and Enhancement**

Funding Entity: NYSDEC

Timeline: Releasing in April/May 2025

Funding Cap:
- Wetland Habitat Restoration and Enhancement $1,000,000
- Riparian Corridor Habitat Restoration and Enhancement $1,000,000

Match Requirement: 25% of award amount

Type: Planning and Construction

Grant Details:
Wetland Habitat Restoration and Enhancement:
Projects must improve the ecological habitat condition of current and/or historic wetlands of the state including marshes, swamps, bogs, fens and other wetland types, with the intent to support fish and wildlife and other biota.

Riparian Corridor Habitat Restoration and Enhancement:
Projects must improve ecological habitat condition of the state including stream and river channels (bed and banks) and the associated riparian buffer (up to 100 feet from the stream banks on both sides) with the intent to support fish and wildlife, and other biota.

Eligible Projects:
Wetland Habitat Restoration and Enhancement:
Projects may involve activities like:
- Removal of historic fill.
- Revegetation of dredged wetland habitats and buffers.
- Restoration of wetland hydrology through the removal of tiles, ditching, other drainage or diversion structures, or other structures, or other constructions or conditions that impact, impair, or influence surface or subsurface movement.
- Control and management of invasive or native plant species and replanting with native species.
- Enhancement of wetland habitat functions and values.
- Reestablishment or enhancement of benthic/littoral zone topography to create shallow-water vegetated habitats.
- Other similar actions.

Riparian Corridor Habitat Restoration and Enhancement:
Projects may involve activities like:
- Installation of in-stream/in-channel habitat structures, features, and improvements using natural channel design principles including rock or wooden deflectors, cribbing, lunkers, rock vanes, rock piles, boulders, engineered log jams, gravel bars, step pools, etc.
- Restoration or enhancement of natural channel sinuosity.

- Installation of fish passage structures.
- Restoration or enhancement of riparian buffers through planting or other means of revegetation to provide shading, thermal protection, overhead cover, terrestrial habitat connectivity, etc.; or
- Other similar management actions.

Website: WQIP 2024 Program Overview

I've also attached a copy of an excel table provides detail on other grant opportunities that have already closed but could be a possibly funding source in the future.

If you have additional questions or require additional information, please do not hesitate to contact me.

Sincerely,

Megan A. Boberg

Grant Name	Funding Entity	Timeline	Funding Cap	Match %	Planning or Construction	Website	Most recent NOFO	Grant Details	Eligible Projects
Flood Mitigation Assistance (FMA) Swift Current	FEMA	February 29, 2024	Up to $600 million	25%	Construction	https://www.fema.gov/grants/mitigation/learn/flood-mitigation-assistance/swift-current		Needs to be an active Natural Disaster declared by FEMA. Swift Current funding is only available to property owners that have a current flood insurance policy under the National Flood Insurance Program (NFIP) and a history of repetitive or substantial damage from flooding.	*Property acquisition and structure demolition/relocation *Structure elevations *Dry floodproofing of historic residential structures or non-residential structures *Non-structural retrofitting of existing structures and facilities *Mitigation reconstruction *Structural retrofitting of existing structures
Hazard Mitigation Grant Program (HMGP)	DHSES	*Only Released for Incident Periods	Funding is based on the estimated total or aggregate cost of disaster assistance: •Up to 15% of the first $2 billion •Up to 10% for amounts between $2 billion and $10 billion •Up to 7.5% for amounts between $10 billion and $35.333 billion •States with enhanced mitigation plans: Up to 20%, not to exceed $35.333 billion	Depends	Planning and Construction	https://www.fema.gov/grants/mitigation/learn/hazard-mitigation	dr-4814-4825-4839-hmgp-cover-sheet.docx	Hazard mitigation includes long-term efforts to reduce risk and the potential impact of future disasters. HMGP assists communities in rebuilding in a better, stronger, and safer way in order to become more resilient overall. The grant program can fund a wide variety of mitigation projects.	**Planning & Enforcement** •Developing and adopting hazard mitigation plans, which are required for state, local, tribal and territorial governments to receive funding for their hazard mitigation projects. •Acquisition of hazard prone homes and businesses which enable owners to relocate to safer areas (acquisition). •Post-disaster code enforcement. **Flood Protection** •Protecting homes and businesses with permanent barriers to prevent floodwater from entering (levees, floodwalls, floodproofing). •Elevating structures above known flood levels to prevent and reduce losses (elevation). •Reconstructing a damaged dwelling on an elevated foundation to prevent and reduce future flood losses. •Drainage improvement projects to reduce flooding (flood risk reduction projects). **Retrofitting** •Structural retrofits to make a building more resistant to floods, earthquakes, wind, wildfire and other natural hazards. •Retrofits to utilities and other infrastructure to enhance resistance to natural hazards (utility retrofits).
NYS Resilient Watershed Grant (RWG)	NYSDOS	June 6, 2025 @ 4 pm	$10,000,000	10%	Planning and Construction	Flood Recovery And Resilience - NYSDEC		Aims to implement projects that enhance community resilience by promoting flood risk reduction, ice jam reduction, and restoration, while supporting healthy riparian habitats and improving water quality.	*Floodplain restoration, creation and/or reconnection to stream *Wetland creation and/or restoration *Berm removal *Dam removal *Stream culvert replacement and right-sizing *Culvert, bridges and appurtenant structures *Streambank, stream channel, or shoreline restoration and/or stabilization and establishment of riparian buffers *Stream daylighting *Acquisition of land
Green Innovation Grant Program (GIGP)	NYEFC (Environmental Facilities Corporation)	April 11, 2025 @ 5 pm	90% of eligible project costs	25%	Planning and Construction	Green Innovation Grant Program Summary https://efc.ny.gov/gigp		Green stormwater infrastructure projects improve water quality by reducing and treating stormwater at its source through infiltration and/or evapotranspiration. Green stormwater infrastructure projects selected for funding go beyond offering a greener solution. Green stormwater infrastructure practices treat rainwater as a valuable resource to be harvested and used on site or filtered and allowed to soak into the ground, recharging aquifers, rivers and streams. The plants used in green stormwater infrastructure help to cool surroundings and improve air quality through the process of evapotranspiration. These green practices have multiple benefits, which include restoring habitat, addressing flood mitigation and resiliency, providing cleaner air and beautifying streets to spur economic development and community revitalization.	Regional Green Stormwater Infrastructure - projects utilize green stormwater infrastructure to restore natural landscape features, such as floodplains, riparian buffers, streams and wetlands. These natural features provide water quality benefits and enhance watersheds, while preserving wildlife and their habitat. Local Green Stormwater Infrastructure - projects that are typically located in an urban environment and consist of site and neighborhood specific practices, such as bioretention, cisterns, downspout, disconnections, green roof, green walls, permeable pavements, stormwater street trees, and urban forestry programs.
Green Resiliency Grants	NYEFC (Environmental Facilities Corporation)	May 1, 2025	$1 million up to $10 million	10%	Planning and Construction	Green Resiliency Grants | Environmental Facilities Corporation	https://www.governor.ny.gov/news/earth-day-governor-hochul-announces-60-million-environmental-bond-act-funding-green-resiliency	Designed to support flood-prone communities in implementing transformative green infrastructure projects that combat the effects of climate change.	Eligibility - projects must have a minimum total project cost of $1 million and be capable of capturing, treating or reducing a minimum of 100,000 cubic feet of stormwater runoff annually. The second round will prioritize offering significant flood risk reduction, helping communities build storm-ready infrastructure that provides long-term solutions and stability.

Water Quality Improvement Project (WQIP) - **Non-Agricultural Nonpoint Source Abatement and Control**	NYSDEC	Typically Released in May/June	$100,000 to $10,000,000 depending on the project subtype and population. • Green Infrastructure Practices $2,000,000/$10,000,000 • Streambank/Shoreline Stabilization $1,000,000 • Riparian Buffers $100,000 • Stream Culvert Repair and Replacement $1,000,000 • Non-point Source Program $4,000,000	25% of award amount	Planning and Construction	WQIP 2024 Program Overview		Funding is available for non-agricultural nonpoint source projects or programs that improve a documented water quality impairment, promote flood risk reduction, enhance flood and climate resiliency, and restoration or that protect a drinking water source.	Green Infrastructure Practices: • Projects to address combined sewer overflows, reduce a pollutant impacting a waterbody or address a regional water quality issue; provide resiliency to impacts from climate change; or reduce localized flooding; or projects to install green infrastructure practices designed to capture and remove the pollutant contributing to a water quality impairment. Streambank/Shoreline Stabilization: • Projects to reduce sedimentation of waterbodies caused by eroding streambanks, shorelines, and/or to filter surface runoff with riparian buffer vegetation. Riparian Buffers • Projects to replant vegetation within the riparian zone of waterbodies to filter nutrients and sediment, prevent streambank/shoreline erosion, reduce thermal impacts to the waterbodies and increase flood resiliency. Stream Culvert Repair and Replacement • Projects to reduce erosion, mitigate flooding and the impacts to climate change, and protect surrounding infrastructure caused by failing or inadequately sized stream culvert through culvert repair or replacement. Nonpoint Source Program • Projects to implement particular nonpoint source BMPs within a defined geographic area. Geographic areas include, but are not limited to: counties, watersheds, municipalities, or sanitary sewer overflow (SSO) areas.
Water Quality Improvement Project (WQIP) - **Fish and Wildlife Habitat Restoration and Enhancement**	NYSDEC	Typically Released in May/June	$1,000,000	25% of award amount	Planning and Construction	WQIP 2024 Program Overview	Projects that improve aquatic connectivity at road/stream crossings or dams and may promote flood risk reduction and enhanced flood and climate resiliency.	Wetland Habitat Restoration and Enhancement: Projects must improve the ecological habitat condition of current and/or historic wetlands of the state including marshes, swamps, bogs, fens and other wetland types, with the intent to support fish and wildlife and other biota. Riparian Corridor Habitat Restoration and Enhancement: Projects must improve ecological habitat condition of the state including stream and river channels (bed and banks) and the associated riparian buffer (up to 100 feet from the stream banks on both sides) with the intent to support fish and wildlife, and other biota.	Wetland Habitat Restoration and Enhancement: Projects may involve activities like: • Removal of historic fill. • Revegetation of dredged wetland habitats and buffers. • Restoration of wetland hydrology through the removal of tiles, ditching, other drainage or diversion structures, or other structures, or other constructions or conditions that impact, impair, or influence surface or subsurface movement. • Control and management of invasive or native plant species and replanting with native species. • Enhancement of wetland habitat functions and values. • Reestablishment or enhancement of benthic/littoral zone topography to create shallow-water vegetated habitats. • Other similar actions. Riparian Corridor Habitat Restoration and Enhancement: Projects may involve activities like: • Installation of in-stream/in-channel habitat structures, features, and improvements using natural channel design principles including rock or wooden deflectors, cribbing, lunkers, rock vanes, rock piles, boulders, engineered log jams, gravel bars, step pools, etc. • Restoration or enhancement of natural channel sinuosity. • Installation of fish passage structures. • Restoration or enhancement of riparian buffers through planting or other means of revegetation to provide shading, thermal protection, overhead cover, terrestrial habitat connectivity, etc.; or •Other similar management actions.
Water Quality Improvement Project (WQIP) - **Aquatic Connectivity Restoration**	NYSDEC	Typically Released in May/June	$1,000,000	25% of award amount	Planning and Construction	WQIP 2024 Program Overview		Projects that improve aquatic connectivity at road/stream crossings or dams and may promote flood risk reduction and enhanced flood and climate resiliency.	*Upgrade and replacement of road stream crossing structures (culverts and bridges) to a larger size and appropriate design to increase the ecological connectivity and hydraulic capacity *Remove or breach of stream barriers such as dams or weirs that limit aquatic connectivity or directly contribute to flooding and meet the natural resource management goals for the area. *Projects that do not meet resource management goals, including those that would have a negative impact on native species, may not be found.
Water Quality Improvement Project (WQIP) - Fish and Wildlife Habitat Restoration and Enhancement	NYSDEC	Typically Released in May/June	$1,000,000	25% of award amount	Planning and Construction	WQIP 2024 Program Overview		Wetland restoration and enhancement; riparian corridor restoration and enhancement.	

Flood Mitigation Assistance (FMA) Grant Program	FEMA	February 27, 2024	$100,000	25%	Planning and Construction	Flood Mitigation Assistance Grant Program | FEMA.gov		The Flood Mitigation Assistance grant program is a competitive program that provides funding to state, territory and local governments and federally recognized Tribal Nations. Since the National Flood Insurance Reform Act of 1994 was signed into law, funds are used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the National Flood Insurance Program. FEMA chooses recipients based on the applicant's ranking of the project, eligibility, and cost-effectiveness of the project. FEMA requires state, local, federally recognized tribal governments, and U.S. territories to develop and adopt hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance, including funding for hazard mitigation assistance projects. For more information, refer to the Hazard Mitigation Assistance Guidance. Properties in a project subapplication for Flood mitigation Assistance funding must be NFIP-insured at the time of the application opening date. The owner must have flood insurance during the mitigation activity and for the life of the structure. This document will provide details on project requirements and scoring criteria: Flood Mitigation Assistance – Individual Flood Mitigation Projects Program Support Material.	**Capability and Capacity Building (C&CB) Activities** •Mitigation Plans for the development or update of a Mitigation Plan(s). Mitigation Plan subapplications will be evaluated to ensure that the result will provide benefits to the NFIP. •Technical Assistance by States to Communities must have received an FY 2022 FMA award of at least $1 million federal cost share. Technical Assistance by States to Communities funding is provided to maintain a viable FMA program over time. •Project Scoping can be used to obtain data and to prioritize, select, and develop future Localized Flood Risk Reduction Projects and/or Individual Flood Mitigation Projects based on current FEMA-approved mitigation plans. Project Scoping subapplications will be evaluated to ensure that the result will lead to an eligible project subapplication that will provide benefits to the NFIP. •Additional Capability and Capacity Building Activities including activities in the following sub-categories: Partnership Development to Conduct Eligible Mitigation Activities, Enhancing Local Floodplain Management, Severe Repetitive Loss /Repetitive Loss Strategy Development, and other eligible Capability and Capacity Building Activities. Localized Flood Risk Reduction Projects (previously Community Flood Mitigation Projects) Localized Flood Risk Reduction Projects address localized flood risk for the purpose of reducing National Flood Insurance Program (NFIP) flood claim payment. **Individual Flood Mitigation Projects** These project types include acquisition, acquisition relocation, relocation, elevation, mitigation reconstruction, and dry floodproofing of historic or commercial structures.
New York State Hazard Mitigation Revolving Loan Fund (HM RLF)	FEMA	April 30, 2024		10%	Planning and Construction	Hazard Mitigation | Division of Homeland Security and Emergency Services	FY24 ST RLF NOFO for 508 review 12-7-2023	New York State's Hazard Mitigation Revolving Loan Fund (HM RLF) has $6.8 million in available funds to support hazard mitigation projects, and these funds can be used as the local match for Hazard Mitigation Grant Program (HMGP) projects.	Entities will use Safeguarding Tomorrow RLF program grants to administer revolving loan funds and provide loans for projects and activities that mitigate the impacts of natural hazards. Eligible projects and activities for loan funding include construction or modification of natural or built infrastructure to increase resilience, building code adoption and enforcement, local zoning and land use planning changes encouraging low-impact development or watershed-level planning, and developing local hazard mitigation plans
New York State Homes and Community Renewal - Resilient Retrofits Term Sheet	NYSHCM	N/A	$50,000 per home, or less	10%	Construction Loan	resilient-retrofits-term-sheet_updated-1.23.2025.pdf		Residential retrofits to achieve climate change mitigation and adaptation of vulnerable single-family homes, which are owned by low- and moderate- income homeowners in New York Ineligible Hard Costs: o Demolition and removal of home ineligible. o Reimbursement of costs for construction work previously incurred are ineligible. Improvements unrelated to a storm or extreme weather event are not eligible.	Eligible Hard Costs: o Eligible Flood Mitigation Improvements: Elevation of electrical and HVAC systems and components, securing of fuel tanks, use of flood resistant building materials, installation of flood vents, and installation of backflow valves, as well as other flood mitigation improvements may be eligible. o Eligible Storm Mitigation Improvements: Storm shutters, shatter-proof glass windows, and other storm mitigation improvements may be eligible. o Eligible Energy Efficiency Improvements: Installing insulation in the walls, ceiling, and floors, reducing air infiltration and pressure imbalances, sealing and repairing ducts, and other energy efficiency improvements may be eligible. o Eligible Purchase and Installation of Appliances: Replacement of appliances with energy efficient appliances and/or high-performance windows or other fixtures may be eligible. o Eligible Purchase and Installation of All-Electric HVAC: Fossil- fuel combustion heating and cooling systems, which are at the end of their useful life, may be eligible for replacement with air- or ground-source heat pump systems. o Eligible Non-Luxury Improvements: Improvements when necessary to render a home compliant with local and state building codes may be eligible. o Eligible Site-Work: Any type of site-work, such as securing the shoreline, bluff, or bulkheads, would be eligible under this program if affected by a storm or an extreme weather event. An inspection or proof of insurance claim denial (if applicable) would be required to perform these improvements and verify direct storm effects. Eligible Soft Costs: Soft costs may include, but are not limited to, contractor fees, building permit filing fees, elevation certificates and other architecture and engineering services, home energy audits, loan closing fees, legal fees…etc.

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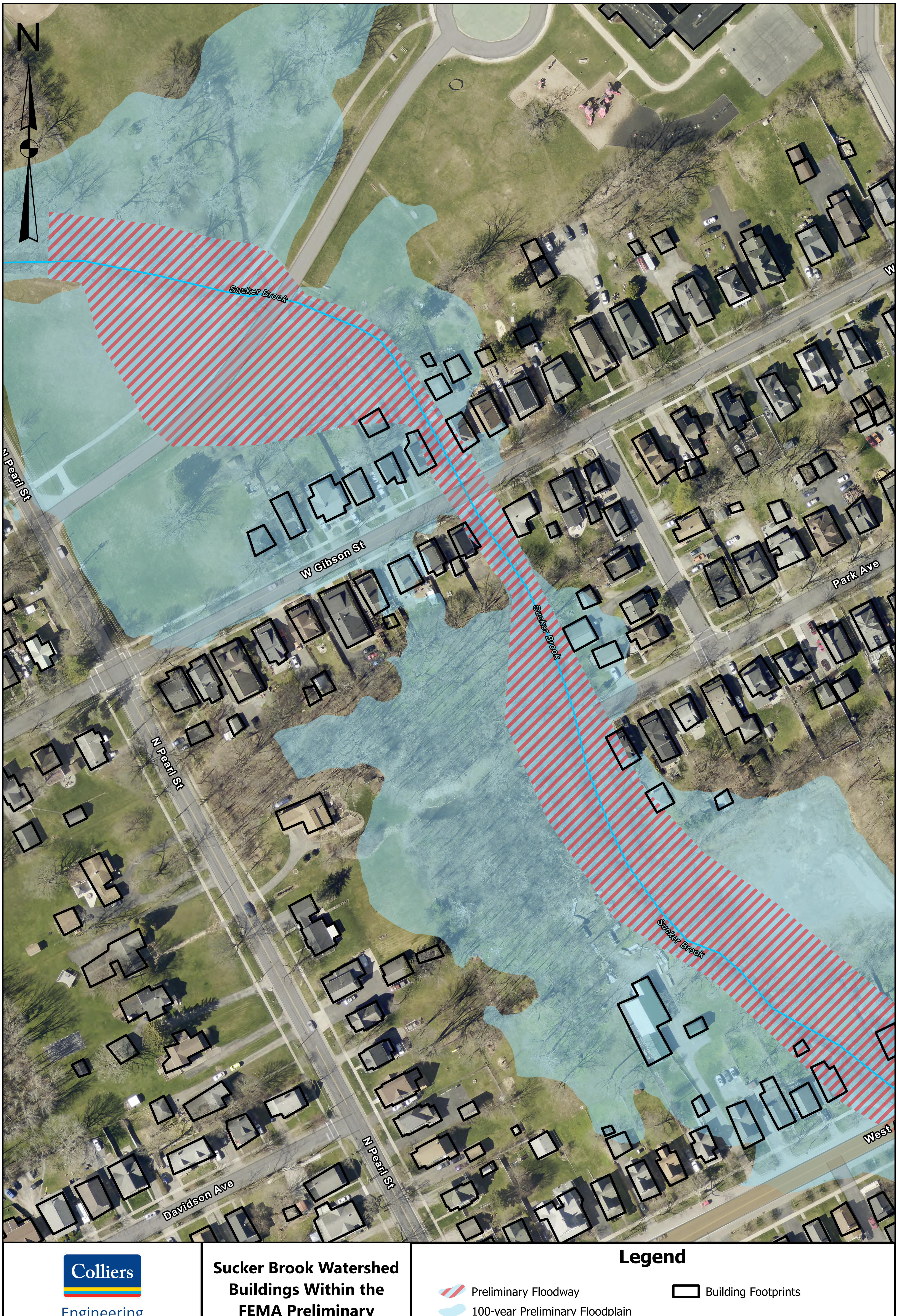
Appendix 3

Floodplain Maps



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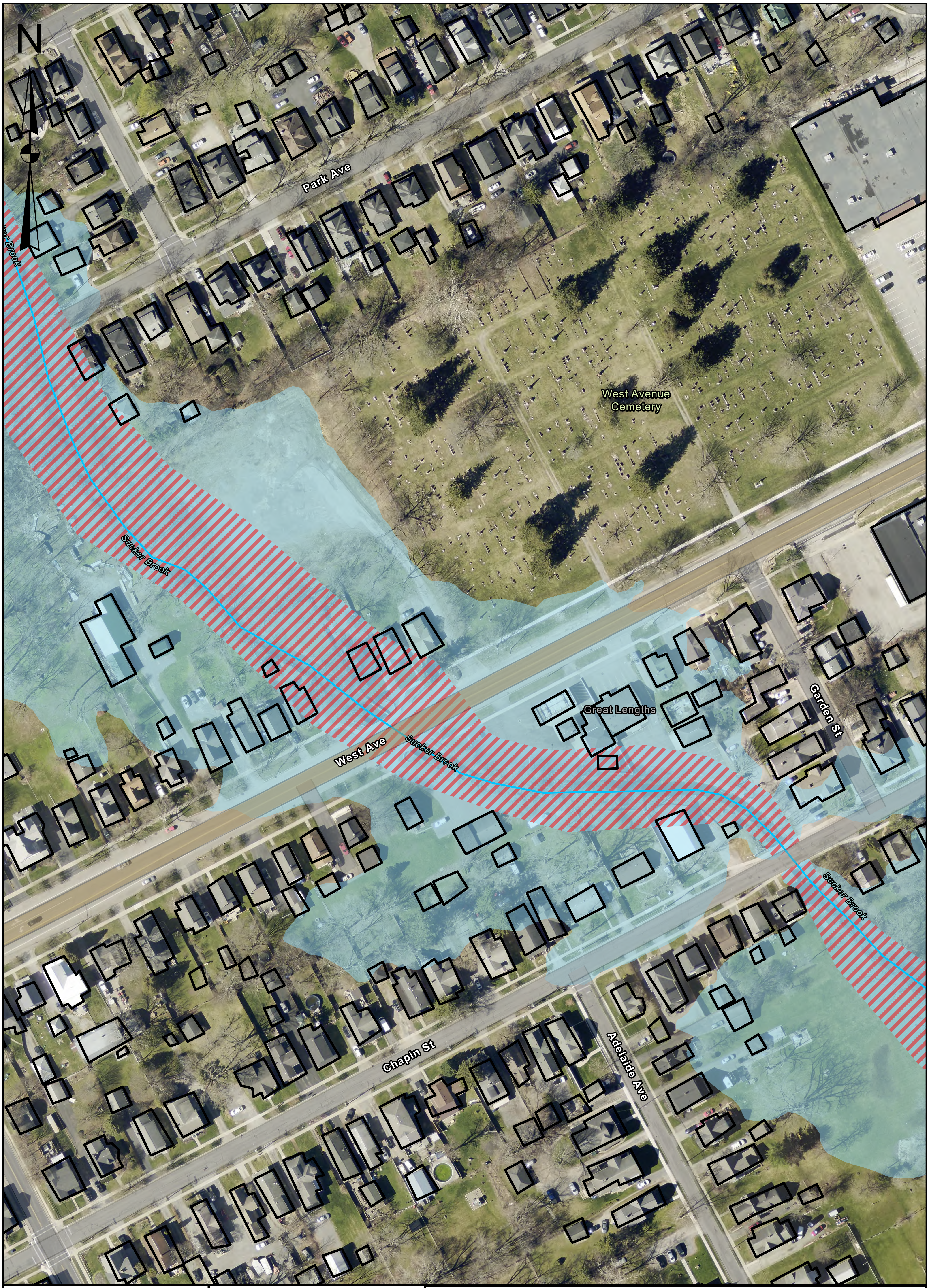
Sucker Brook Watershed Buildings Within the FEMA Preliminary Floodplain

04/29/2025

Legend

- Preliminary Floodway
- 100-year Preliminary Floodplain
- Building Footprints

0 50 100 150 200
Feet



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