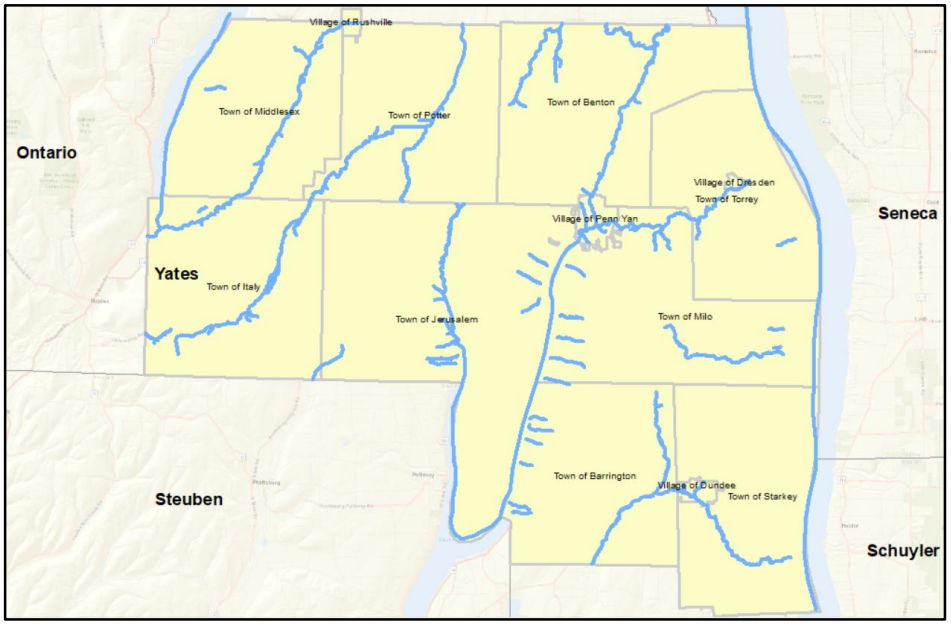
RiskMAP
Increasing Resilience Together

Flood Risk Project

Yates County, New York, Hydrology Meeting

September 30, 2019

FEMA



Presentation Agenda

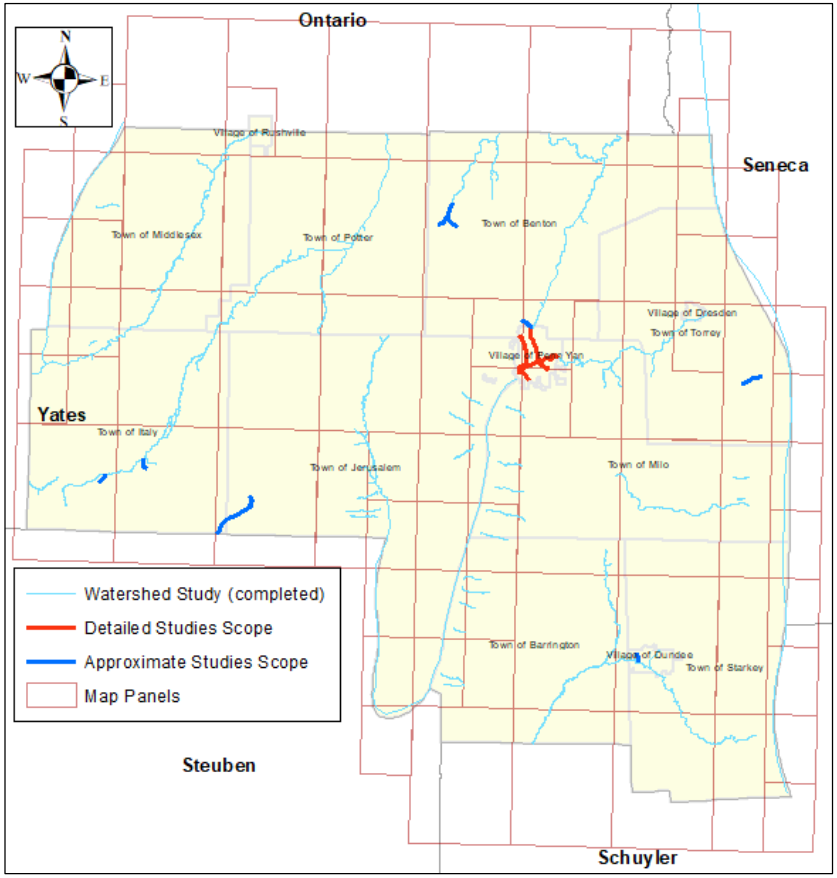
- Project Recap
- Project Scope
- Hydrologic Analysis Task Scope
- Hydrologic Analysis & Results
- Schedule

Project Recap

- **Discovery – 2015**
- **Seneca Watershed Study - 2018**
- **This Study**
  - Continuation of 2018 watershed study
  - Kickoff meeting: March 7, 2019
  - Engineering models notification to communities: April 1, 2019
  - Hydrologic analysis: April 2019 – Present
  - Field survey: April 2019 – September 2019

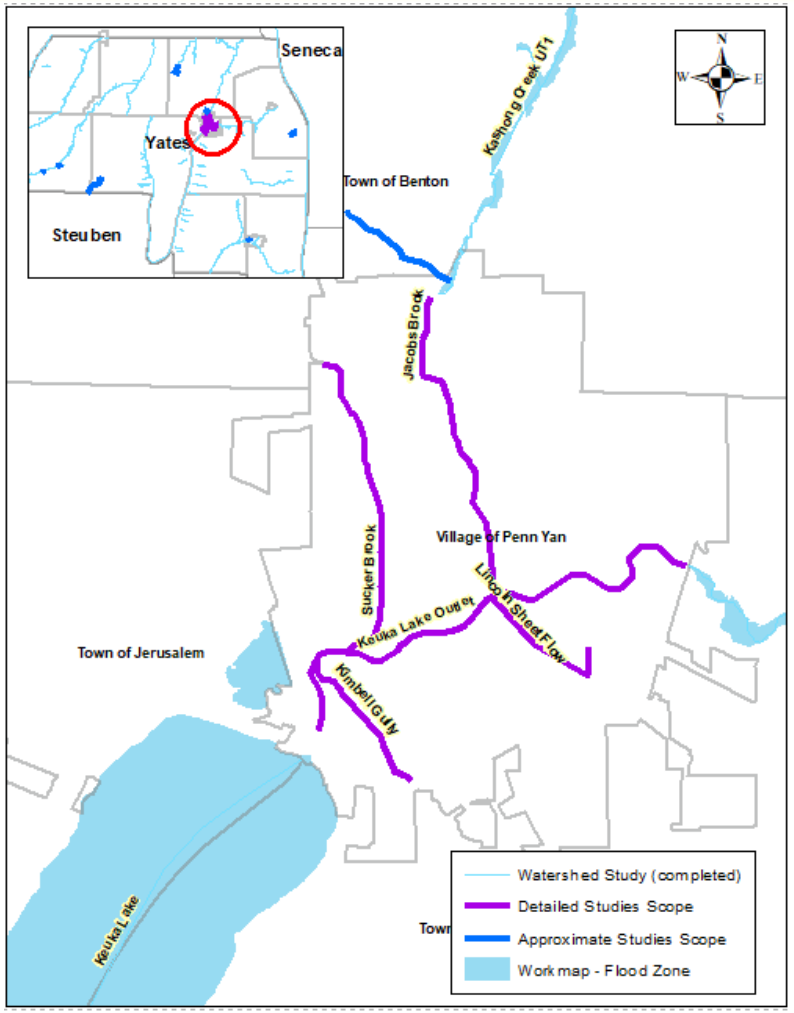
Project Scope

- **First time digital countywide maps**
- **Additional flooding sources studied**
  - 5.1 miles - Detailed (AE) streams
  - 5.4 miles – Approximate (A) streams
- **Includes 211 miles of 2018 Seneca Watershed study**
  - 41.9 miles – Detailed (AE)
  - 164.0 miles – Approximate (A)
  - 5.1 miles – Redelineation
- **13 affected communities**
- **74 map panels**
- **Multiple touchpoints**



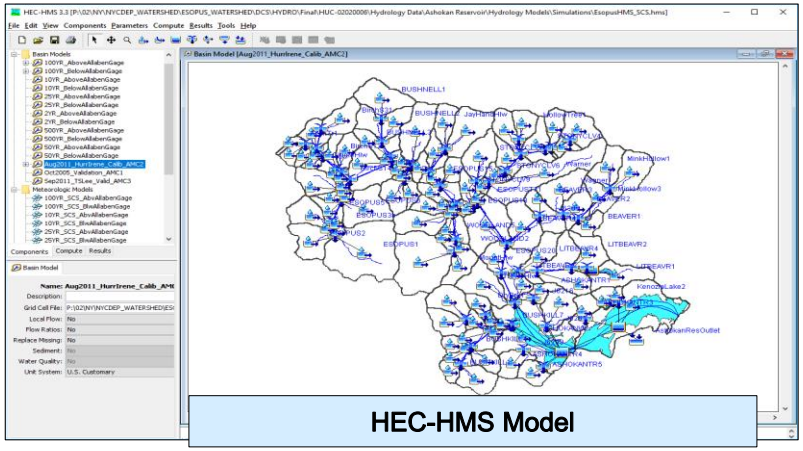
Hydrologic Analysis Task Scope

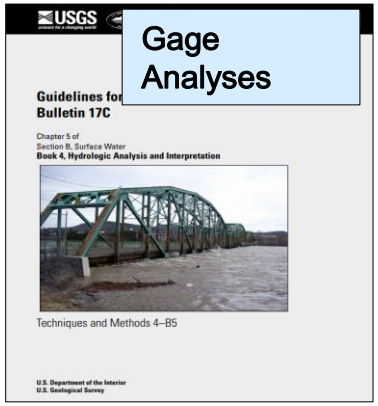
- **5 Detailed (AE) study flooding sources**
  - Keuka Lake Outlet -1.8 miles
  - Jacobs Brook -1.1 miles
  - Kimbell Gully - 0.6 miles
  - Lincoln Sheet Flow - 0.5 miles
  - Sucker Brook - 1.1 miles
- **9 Approximate (A) streams, totaling 5.4 miles**
- **Hydrologic analyses**
  - Gage analyses - Keuka Lake Outlet
  - Rainfall-runoff modeling for other 4 AE streams
  - Regression analyses for all A streams
- **Discharges developed:** 10%, 4%, 2%, 1% (Base Flood), 1%+, 1%-, 0.2%



Hydrologic Analysis Methods

- **Typical FEMA methods**
  - Rainfall runoff analyses
  - Statistical gage analyses
  - Regression analyses
- **Rainfall-runoff analyses**
  - Physical modeling
  - USACE HEC-HMS program
- **Statistical Gage analyses**
  - Statistical analyses of flow/stage gage data
  - USGS PeakFQ program
- **Regression analyses**
  - Regional equations published by USGS
  - USGS StreamStats web application
- **Develop inputs for hydraulic analysis**

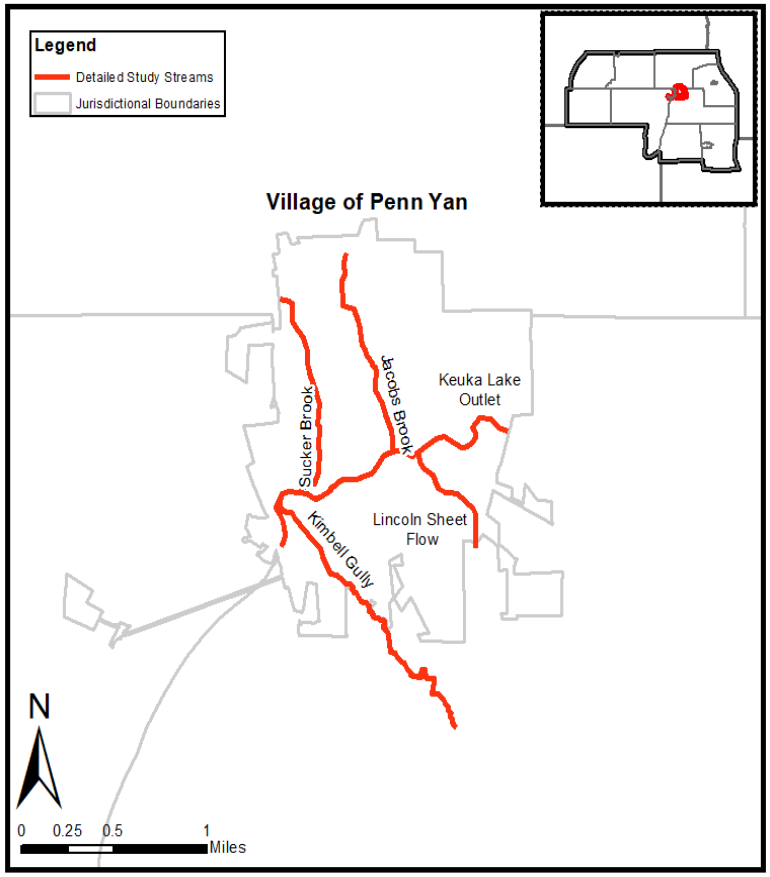




Detailed Studies

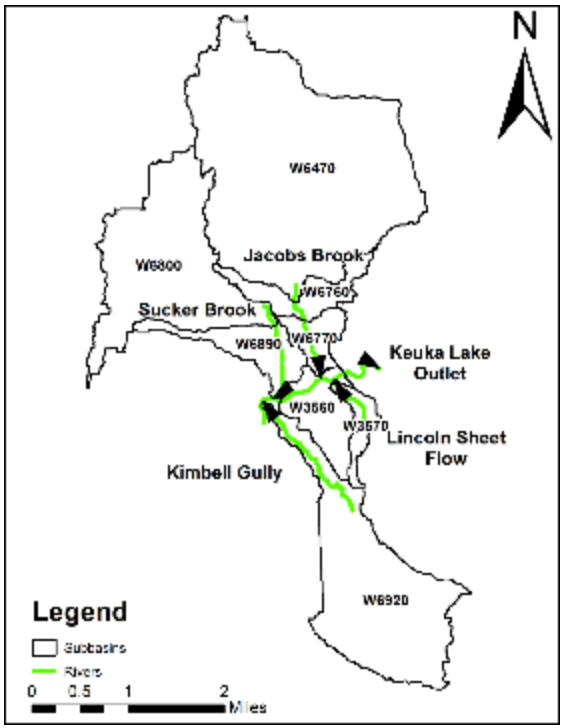
- All detailed studies are mostly located in Village of Penn Yan
- Small drainage areas, with exception of Keuka Lake Outlet

Study Stream Name	Length (mi)	Drainage Area at Mouth (mi^2)	Hydrologic Method Used
Jacobs Brook	1.10	5.13	Rainfall Runoff Method - HEC-HMS
Kimbell Gully	1.79	2.13	
Sucker Brook	1.10	2.52	
Lincoln Sheet Flow	0.64	0.19	
Keuka Lake Outlet	1.78	187	Bulletin 17C



Detailed Studies – Rainfall Runoff Modeling

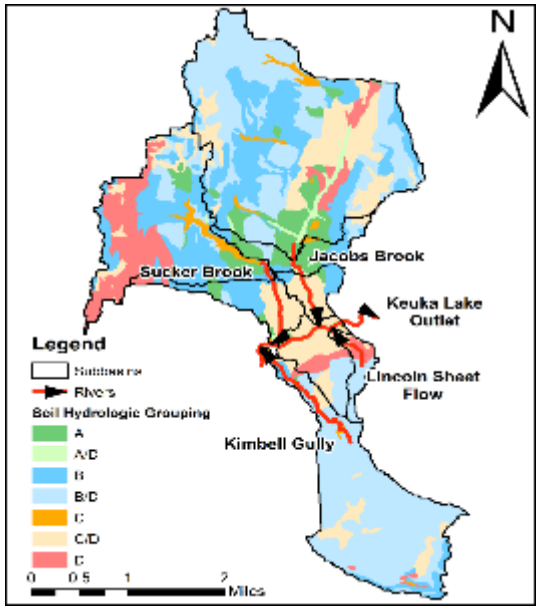
- **USACE HEC-HMS 4.3 model applied**
- **Topography:**
  - 2012 LiDAR Digital Elevation Model (DEM) - 2m resolution
  - Used for basin and flow path delineations, length and slope calculations
- **Rainfall Loss Method:**
  - Soil Conservation Service (SCS) Curve Number (CN)
- **Runoff Hydrograph Method:**
  - SCS Unit Hydrograph
- **Flood Channel Routing Method:**
  - Muskingum-Cunge using 8-point cross section
- **Flood Frequency Storms: NOAA Atlas 14**
- **No stream gage available for calibration**
- **Regression analysis developed for validation**



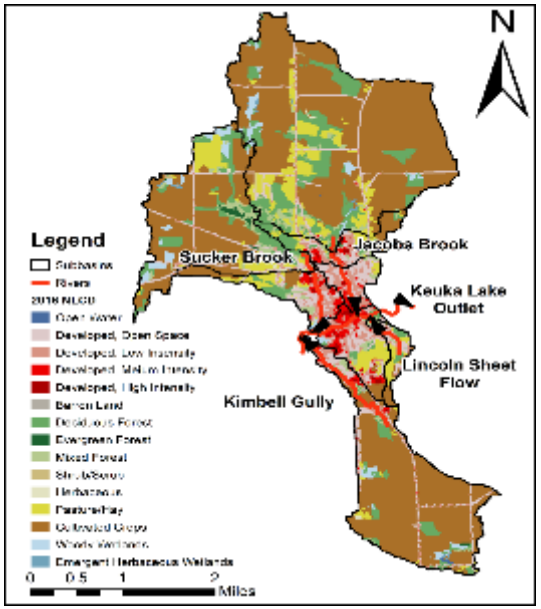
Rainfall-Runoff Modeling
SCS Curve Numbers

- Runoff = Rainfall – initial abstractions – infiltration
- Function of empirical parameter: Curve Number (CN)
- NRCS Soil Data – Soils Survey Geographic Database (SSURGO)
- USGS Landuse Data – National Land Cover Dataset (NLCD)

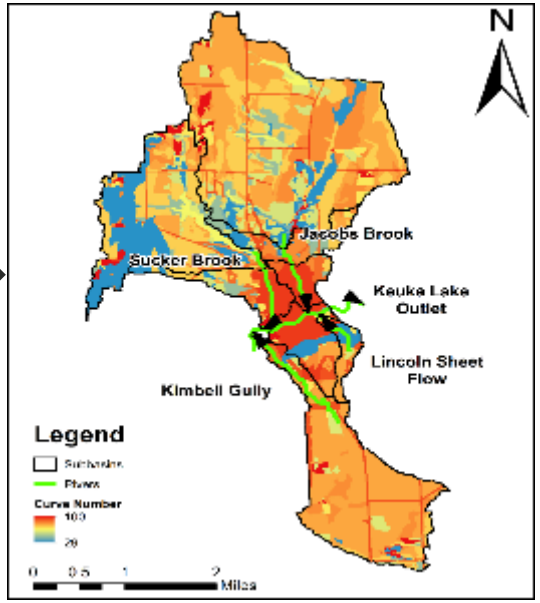
Soils



Land Use



Curve Number

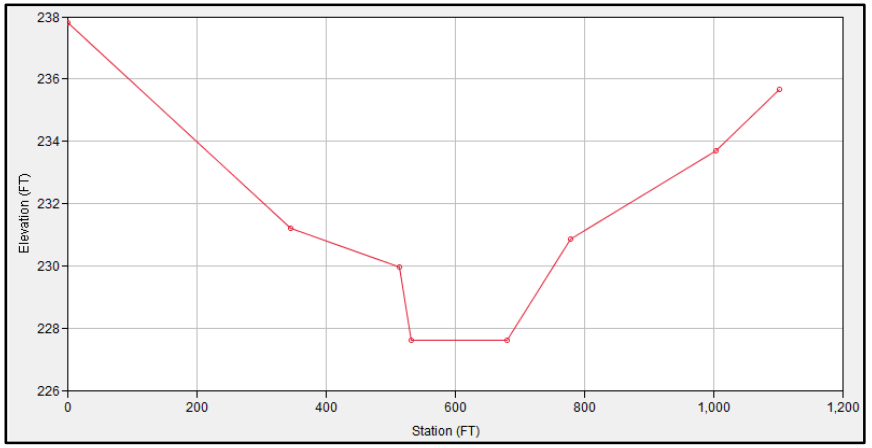


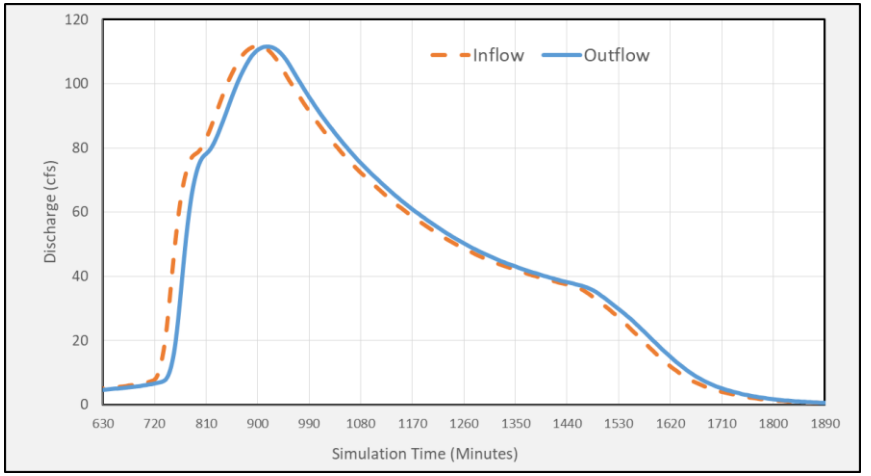
Rainfall-Runoff Modeling
Time of Concentration (Tc)/Lag Time

- **Tc = time for runoff to travel from hydraulically distant point to the outlet of a basin or sub-basin**
- **Longest flow paths developed from project DEM**
- **Flow paths split into different types:**
  - Sheet flow maximum = 100 ft
  - Shallow concentrated flow: from end of sheet flow segment to visual open channel
  - Channel flow: begins at end of shallow concentrated flow segment and ends at sub-basin outlet
- **Lag times = 60% of Tc**
  - Model values range from 37 minutes to 131 minutes

Rainfall-Runoff Modeling
Reach Routing

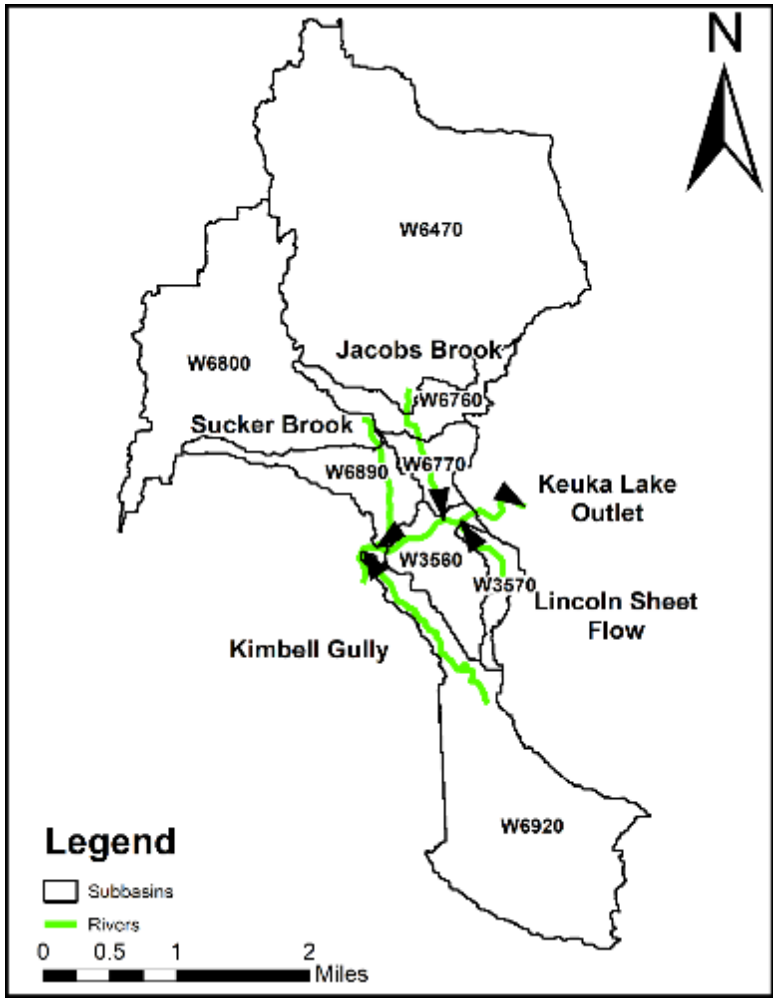
- Account for flow attenuation and travel time of flood waves
- Individual sub-basin hydrographs routed downstream along the channels
- Eight point cross-sections capture channel and overbank
- Length, elevations, and slope determined from DEM
- Channel and overbank Manning's n values determined from imagery





Rainfall-Runoff Modeling
Summary of Model Parameters

Sub-Basin	Drainage Area (mi^2)	Curve Number	Percent Impervious	Lag Time (Mins)
W6470	4.5	50.5	2.0%	130.7
W6800	2.0	52.3	4.1%	111.8
W6760	0.4	61.0	0.2%	42.7
W6890	0.5	73.7	5.4%	67.1
W6770	0.3	70.4	0.0%	36.9
W3570	0.2	60.8	0.0%	45.9
W6920	2.1	61.5	2.3%	117.5



Rainfall-Runoff Modeling
Frequency Storm Rainfall Data

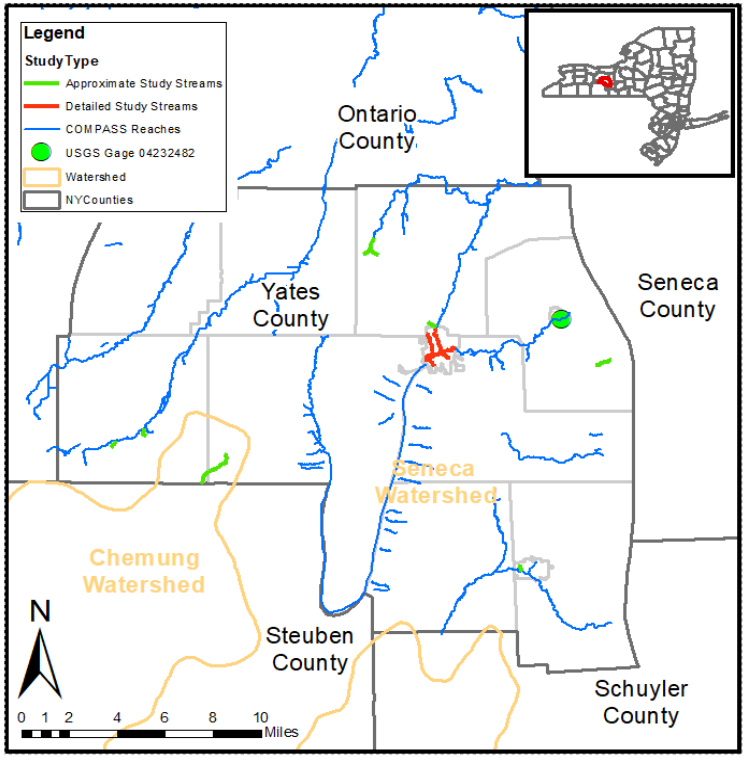
- NOAA Atlas 14-point precipitation estimates
- Model-wide estimates:
  - 24-hour rainfall modeled
  - 100-year rainfall: 5.29 inches
- Same chart used for other frequencies
- "Frequency storm" distribution type used in HEC-HMS

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	0.287 (0.226-0.353)	0.350 (0.275-0.431)	0.453 (0.355-0.559)	0.538 (0.420-0.668)	0.656 (0.495-0.852)	0.744 (0.550-0.987)	0.838 (0.602-1.16)	0.948 (0.640-1.33)	1.11 (0.720-1.61)	1.25 (0.788-1.84)
10-min	0.406 (0.320-0.499)	0.496 (0.390-0.610)	0.642 (0.503-0.792)	0.763 (0.595-0.947)	0.929 (0.702-1.21)	1.05 (0.779-1.40)	1.19 (0.853-1.64)	1.34 (0.906-1.88)	1.57 (1.02-2.28)	1.77 (1.12-2.60)
15-min	0.478 (0.377-0.588)	0.583 (0.459-0.718)	0.755 (0.592-0.932)	0.898 (0.701-1.12)	1.09 (0.825-1.42)	1.24 (0.916-1.65)	1.40 (1.00-1.93)	1.58 (1.07-2.21)	1.85 (1.20-2.68)	2.08 (1.31-3.06)
30-min	0.644 (0.508-0.792)	0.785 (0.618-0.967)	1.02 (0.797-1.25)	1.21 (0.942-1.50)	1.47 (1.11-1.91)	1.67 (1.23-2.22)	1.88 (1.35-2.59)	2.13 (1.44-2.98)	2.49 (1.61-3.60)	2.79 (1.77-4.12)
60-min	0.810 (0.638-0.996)	0.988 (0.778-1.22)	1.28 (1.00-1.58)	1.52 (1.19-1.89)	1.85 (1.40-2.40)	2.10 (1.55-2.79)	2.36 (1.70-3.26)	2.67 (1.80-3.74)	3.13 (2.03-4.53)	3.51 (2.22-5.18)
2-hr	1.01 (0.801-1.23)	1.22 (0.964-1.49)	1.56 (1.23-1.91)	1.84 (1.44-2.26)	2.22 (1.69-2.88)	2.50 (1.87-3.33)	2.82 (2.06-3.91)	3.22 (2.18-4.47)	3.86 (2.51-5.54)	4.42 (2.81-6.46)
3-hr	1.14 (0.909-1.39)	1.37 (1.09-1.67)	1.74 (1.38-2.12)	2.04 (1.61-2.51)	2.46 (1.89-3.18)	2.77 (2.08-3.67)	3.11 (2.29-4.32)	3.56 (2.42-4.93)	4.30 (2.80-6.14)	4.96 (3.16-7.21)
6-hr	1.40 (1.12-1.69)	1.66 (1.33-2.01)	2.09 (1.67-2.54)	2.45 (1.94-2.99)	2.94 (2.27-3.77)	3.30 (2.50-4.34)	3.70 (2.74-5.09)	4.23 (2.88-5.80)	5.08 (3.32-7.20)	5.84 (3.73-8.41)
12-hr	1.69 (1.36-2.03)	2.01 (1.62-2.41)	2.52 (2.03-3.04)	2.95 (2.35-3.57)	3.54 (2.73-4.48)	3.98 (3.01-5.15)	4.45 (3.27-5.99)	5.02 (3.44-6.83)	5.90 (3.88-8.28)	6.66 (4.26-9.51)
24-hr	1.99 (1.62-2.37)	2.37 (1.92-2.83)	2.99 (2.41-3.58)	3.50 (2.81-4.21)	4.21 (3.26-5.27)	4.73 (3.59-6.05)	5.29 (3.88-7.01)	5.94 (4.09-7.99)	6.88 (4.54-9.56)	7.66 (4.92-10.8)
2-day	2.30 (1.88-2.72)	2.74 (2.24-3.25)	3.47 (2.82-4.13)	4.08 (3.29-4.87)	4.91 (3.82-6.11)	5.53 (4.21-7.02)	6.19 (4.57-8.14)	6.96 (4.81-9.28)	8.08 (5.35-11.1)	9.03 (5.82-12.6)
3-day	2.53 (2.07-2.98)	3.01 (2.47-3.55)	3.80 (3.10-4.50)	4.46 (3.62-5.30)	5.36 (4.19-6.65)	6.04 (4.61-7.63)	6.75 (5.00-8.85)	7.59 (5.26-10.1)	8.83 (5.86-12.1)	9.86 (6.37-13.7)
4-day	2.72 (2.24-3.20)	3.23 (2.66-3.81)	4.06 (3.33-4.80)	4.76 (3.87-5.64)	5.71 (4.47-7.05)	6.42 (4.92-8.08)	7.17 (5.32-9.36)	8.05 (5.59-10.6)	9.35 (6.22-12.7)	10.4 (6.75-14.5)
7-day	3.23 (2.67-3.78)	3.78 (3.12-4.43)	4.68 (3.86-5.50)	5.44 (4.44-6.41)	6.47 (5.10-7.93)	7.24 (5.57-9.05)	8.06 (5.99-10.4)	9.01 (6.28-11.8)	10.4 (6.93-14.1)	11.5 (7.48-15.9)
10-day	3.70 (3.07-4.32)	4.29 (3.56-5.00)	5.25 (4.33-6.14)	6.04 (4.95-7.10)	7.13 (5.63-8.70)	7.95 (6.13-9.88)	8.81 (6.55-11.3)	9.79 (6.85-12.8)	11.2 (7.49-15.1)	12.3 (8.03-16.9)
20-day	5.16 (4.31-5.97)	5.82 (4.86-6.74)	6.91 (5.74-8.02)	7.81 (6.44-9.11)	9.05 (7.18-10.9)	9.99 (7.72-12.3)	11.0 (8.14-13.8)	12.0 (8.43-15.5)	13.4 (9.00-17.9)	14.5 (9.46-19.7)
30-day	6.38 (5.35-7.36)	7.10 (5.95-8.19)	8.27 (6.90-9.57)	9.24 (7.66-10.7)	10.6 (8.42-12.7)	11.6 (8.99-14.1)	12.6 (9.39-15.8)	13.7 (9.67-17.6)	15.1 (10.2-20.0)	16.1 (10.5-21.7)
45-day	7.92 (6.67-9.09)	8.69 (7.31-9.98)	9.95 (8.33-11.5)	11.0 (9.15-12.7)	12.4 (9.92-14.8)	13.6 (10.5-16.4)	14.6 (10.9-18.1)	15.7 (11.1-20.0)	17.0 (11.5-22.4)	17.9 (11.7-24.0)
60-day	9.22 (7.78-10.5)	10.0 (8.45-11.5)	11.3 (9.52-13.0)	12.4 (10.4-14.3)	13.9 (11.1-16.5)	15.1 (11.8-18.2)	16.3 (12.1-19.9)	17.3 (12.3-22.0)	18.5 (12.5-24.2)	19.3 (12.7-25.8)

Detailed Studies – Gage Analysis

- Only Keuka Lake Outlet has a gage available:
  - USGS Gage 04232482
  - Period of record – 1965 to 2018
  - DA: 207 mi^2 at gage vs 187 mi^2 at study limit
- Recently published Bulletin 17C, codified in USGS PeakFQ 7.2 program
- Seneca watershed study used Bulletin 17B using 1966 to 2015 records
- PeakFQ results are slightly lower with 17C analysis than with 17B

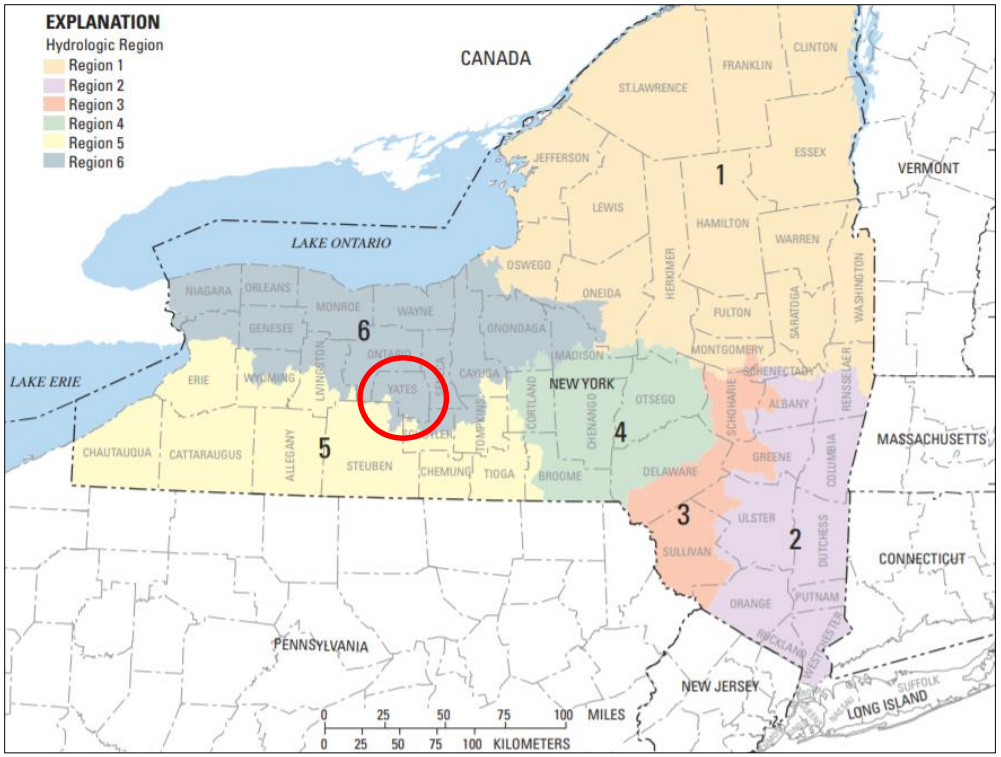


Detailed Studies – Recommended Discharges

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (mi^2)	PEAK DISCHARGES (cfs)						
		10-YEAR	25-YEAR	50-YEAR	100-YEAR	100-YEAR PLUS	100-YEAR MINUS	500-YEAR
Jacobs Brook								
At mouth	4.90	281	488	668	883	1,432	600	1,649
Kimbell Gully								
At mouth	2.10	189	311	415	537	816	384	953
Sucker Brook								
At mouth	2.50	164	277	378	499	713	376	933
Lincoln Sheet Flow								
At mouth	0.19	23	42	59	79	141	50	146
Keuka Lake Outlet								
At Main Street	187.00	2,526	3,134	3,588	4,043	5,778	3,680	5,114

Regression Analysis

- USGS New York regression equation: SIR 2006-5112
- Study area falls within USGS NY regression Region 6
- USGS StreamStats web application employed
- Primary method for A streams,
- Validation of HMS discharges for AE streams



Summary of Regression Equations

USGS NYS Hydrologic Region 6

Q_{10}	$23.4\,(A)^{0.810}\,(ST+0.5)^{-0.218}\,(RUNF)^{0.600}\,(EL12+1)^{0.133}\,(SR)^{0.268}$
Q_{25}	$32.1\,(A)^{0.815}\,(ST+0.5)^{-0.200}\,(RUNF)^{0.555}\,(EL12+1)^{0.148}\,(SR)^{0.290}$
Q_{50}	$39.0\,(A)^{0.819}\,(ST+0.5)^{-0.188}\,(RUNF)^{0.528}\,(EL12+1)^{0.157}\,(SR)^{0.305}$
Q_{100}	$46.0\,(A)^{0.823}\,(ST+0.5)^{-0.177}\,(RUNF)^{0.505}\,(EL12+1)^{0.166}\,(SR)^{0.318}$
Q_{200}	$53.2\,(A)^{0.828}\,(ST+0.5)^{-0.167}\,(RUNF)^{0.487}\,(EL12+1)^{0.173}\,(SR)^{0.330}$
Q_{500}	$62.7\,(A)^{0.834}\,(ST+0.5)^{-0.155}\,(RUNF)^{0.466}\,(EL12+1)^{0.183}\,(SR)^{0.345}$

A: Drainage area in square miles

ST: Basin storage in % of drainage area

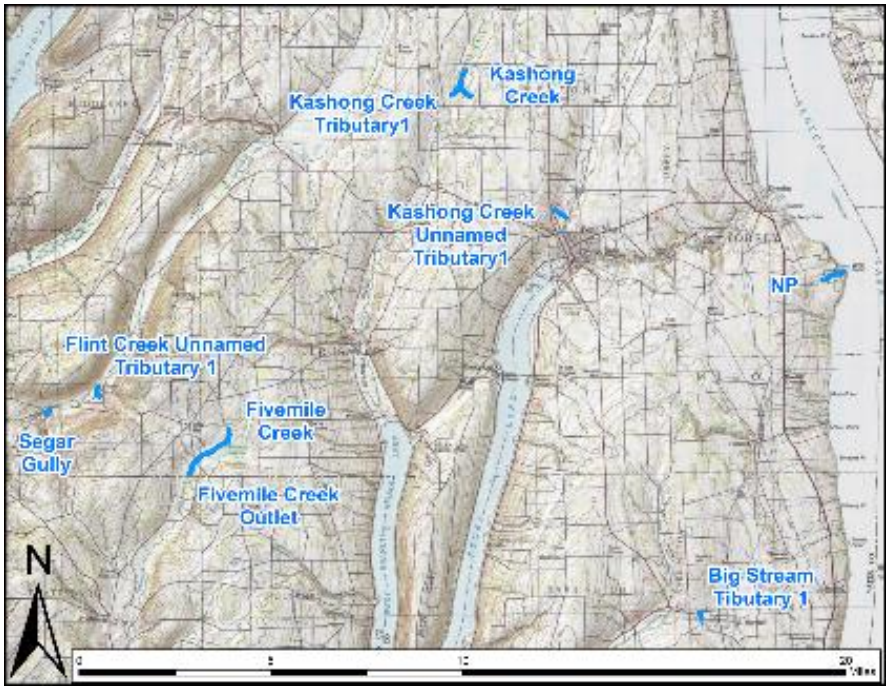
RUNF: Mean annual runoff in inches

EL12: Percentage of drainage basin at or greater than 1,200 ft above sea level

SR: Slope ratio—ratio of main-channel slope to basin slope within drainage basin

Approximate Studies – Recommended Discharges

Flooding Source	Drainage Area (mi^2)	Q100 (CFS)
Big Stream Trib1	0.11	43.2
Fivemile Creek	9.11	2,140
Fivemile Creek Outlet	9.26	2,170
Flint Creek UT2	0.82	329
Kashong Creek	2.06	158
Kashong Creek Trib 1	0.26	25.8
Kashong Creek UT 1	4.53	445
NP	0.43	62.5
Segar Gully	4.06	1,560



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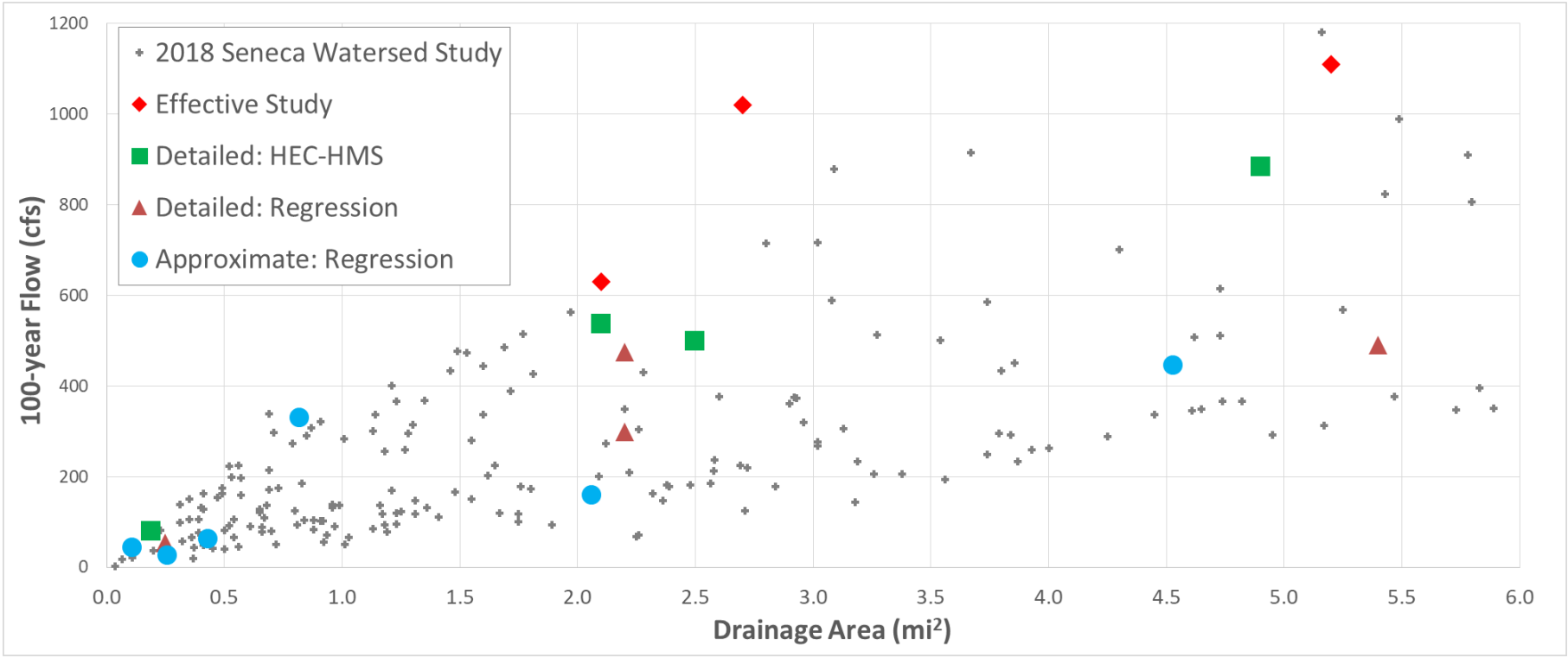
Detailed Studies – Comparison of Results

Flooding Source	Location	FIS 100-Year		Regression 100-Year		This Study 100-Year	
		DA (mi^2)	Q (cfs)	DA (mi^2)	Q (cfs)	DA (mi^2)	Q (cfs)
Jacobs Brook	At mouth	5.2	1,110	5.4	491	4.9	883
Kimbell Gully	At mouth	2.1	630	2.2	298	2.1	537
Sucker Brook	At mouth	2.7	1,020	2.2	475	2.5	499
Lincoln Sheet Flow	At mouth	-	-	0.25	53.4	0.19	79

Comparison of Results

Comparison of Flows Vs Drainage Area for Detailed Streams (DA < 6 mi²)



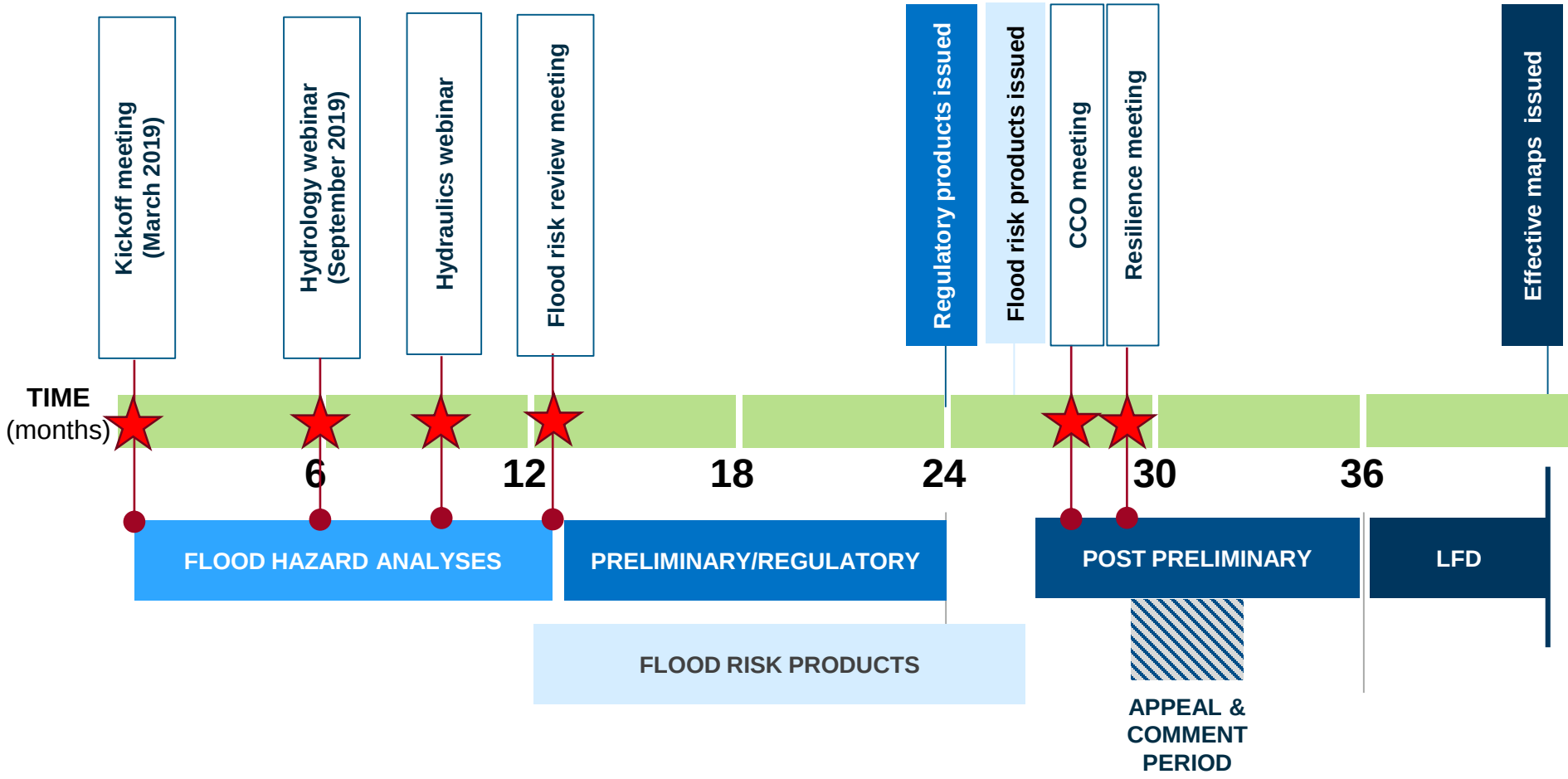
Comparison of Results

- **Gage analyses (Keuka Lake Outlet)**
  - Effective flood study: Flows increase from 1,800 cfs to 4,043 cfs
  - 2018 Seneca Watershed study: Flows decrease due to:
    - Added years of peak annual flow / Method change from Bulletin 17B to 17C
- **Rainfall-runoff modeling (4 AE streams)**
  - Flows larger than regression analysis
- **Regression analyses (approximate streams)**
  - Same method as 2018 watershed study, so no difference in results
- **General results**
  - Discharges lower than effective FIS
  - Detailed and approximate results agree with general range of regression equation results

Next Steps

- **Field reconnaissance**
- **Hydraulic analysis**
  - Hydraulic modeling/report/submittal
  - Hydraulic analysis webinar
- **Flood Risk Review meeting**
- **Dam breach analysis**
- **Mapping**

Schedule


Kickoff meeting (March 2019)
Hydrology webinar (September 2019)
Hydraulics webinar
Flood risk review meeting
Regulatory products issued
Flood risk products issued
CCO meeting
Resilience meeting
Effective maps issued
TIME (months)
6
12
18
24
30
36
FLOOD HAZARD ANALYSES
PRELIMINARY/REGULATORY
POST PRELIMINARY
LFD
FLOOD RISK PRODUCTS
APPEAL & COMMENT PERIOD

Contacts

- **FEMA Project Monitor**
  - Shudipto Rahman
  - 202-702-4273
  - shudipto.rahman@fema.dhs.gov
- **FEMA Outreach Coordinator**
  - Stephanie Gootman
  - 202-802-3137
  - stephanie.gootman@fema.dhs.gov
- **STARR II Project Manager**
  - Srikanth Koka
  - 703-849-0584
  - skoka@dewberry.com
- **STARR II Regional Support Center**
  - Curtis Smith
  - 646-490-3929
  - curtis.smith@stantec.com

Questions? Comments?

Thank you!

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