RiskMAP
Increasing Resilience Together

Flood Risk Project

Orleans County, New York, Hydrology Meeting

October 4, 2019

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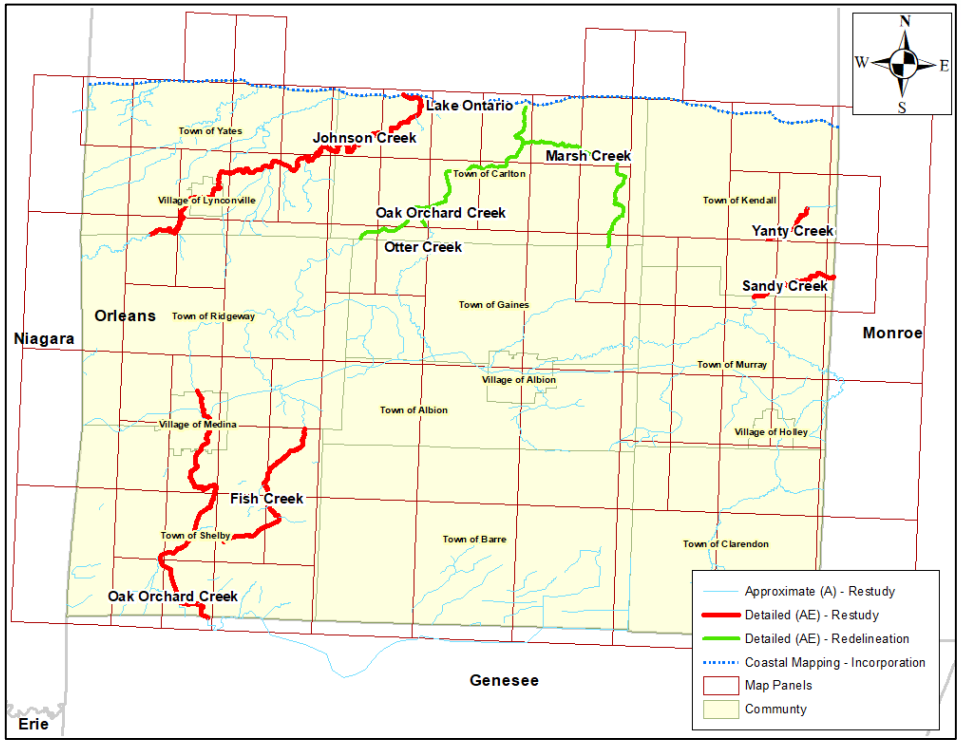
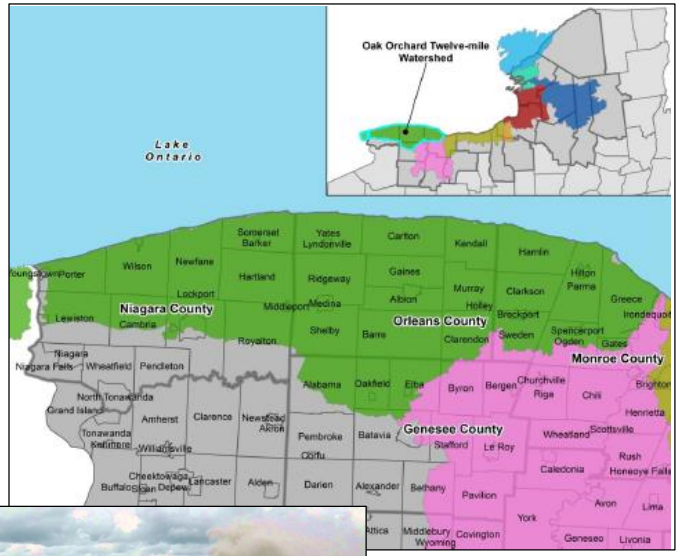


Presentation Agenda

- Project Recap
- Project Scope
- Hydrologic Analysis Task Scope
- Hydrologic Analysis & Results
- Next Steps

Project Recap

- **Discovery – 2016**
- **Lake Ontario Coastal Study –2017**
- **This Study**
  - Kickoff meeting: March 6, 2019
  - Engineering models notification to communities: April 1, 2019
  - Hydrologic analyses: April 2019 – Present
  - Field Survey: April 2019 – September 2019



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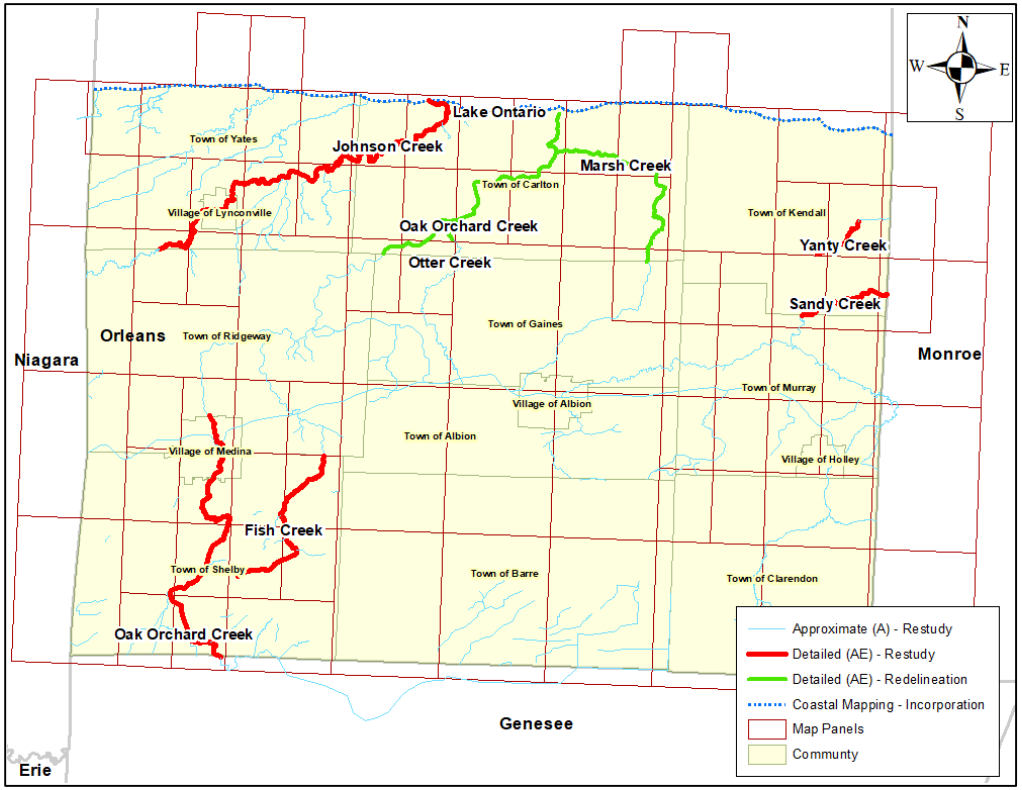
Project Scope

- **First time digital countywide maps**
  - 14 affected communities
  - 86 map panels
- **Incorporates 25 miles of coastal study**
- **Riverine studies within Oak Orchard Twelve-Mile HUC8 Watershed**
- **Multiple outreach touchpoints**

Hydrologic Analysis Task Scope

- **5 Detailed (AE) study flooding sources, totaling 36 miles**
  - Oak Orchard Creek – 10.5 miles
  - Fish Creek – 5.8 miles
  - Johnson Creek – 14.7 miles
  - Sandy Creek – 3.0 miles
  - Yanty Creek – 1.8 miles
- **151 Approximate (A) study flooding sources, totaling 241 miles**
- **26 miles of Erie Canal**
- **Hydrologic analyses**
  - Rainfall-Runoff modeling for all study streams, except Erie Canal
  - Regression Analyses for comparison



- **Discharges developed:** 10%, 4%, 2%, 1% (Base Flood), 1%+, 1%-, 0.2%

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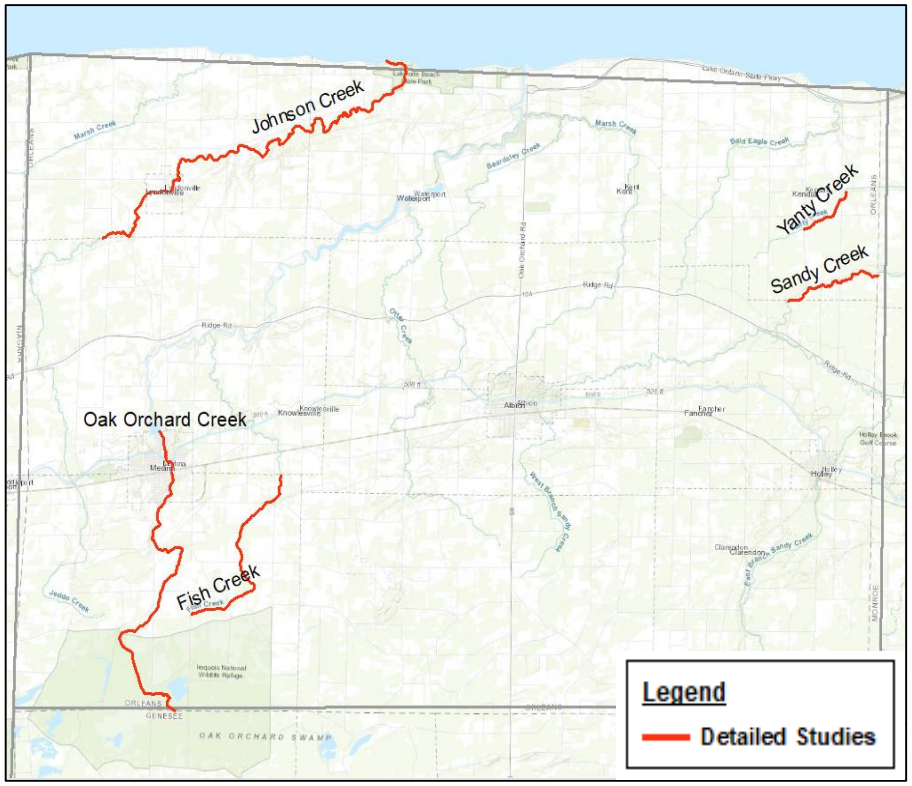
Hydrologic Analysis – Detailed Studies

- Effective hydrologic analysis use the rainfall-runoff methodology (TR-20 model)
- New study also used the rainfall-runoff methodology (HEC-HMS model) for all reaches

Study Stream Name	Length (mi)	Drainage Area at Mouth (mi^2)
Oak Orchard Creek	10.5	284.8
Sandy Creek	3.0	82.3
Yanty Creek	1.8	6.9
Johnson Creek	14.7	112.7
Fish Creek	5.8	15.4



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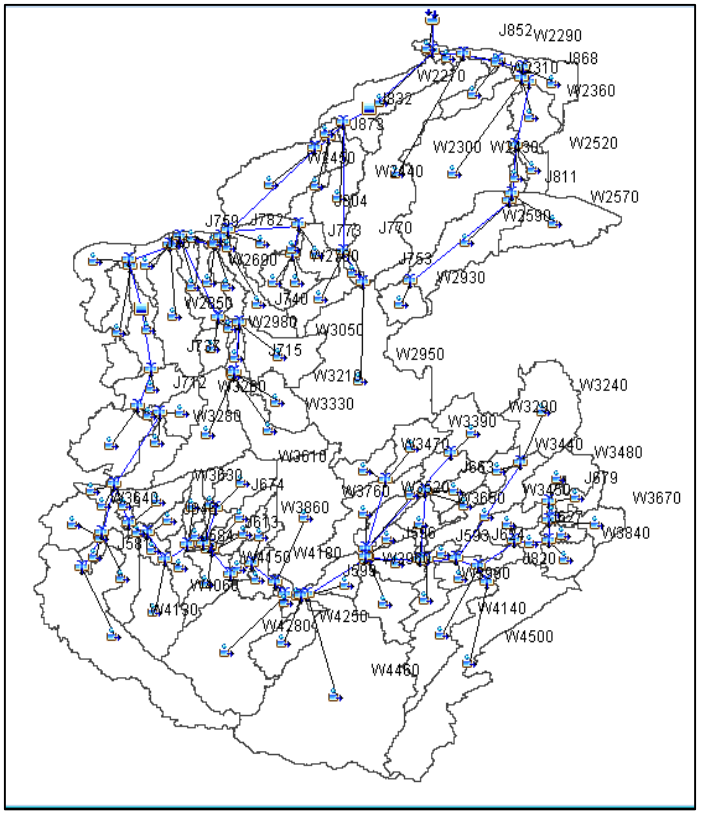
Detailed Studies – Rainfall Runoff Modeling

- **USACE HEC-HMS 4.3 model applied**
- **Watershed sub-basin delineation:**
  - USGS 10m Digital Elevation Model (DEM)
- **Rainfall Loss Method:**
  - Soil Conservation Service (SCS) Curve Number (CN)
- **Runoff Hydrograph Method:**
  - SCS Unit Hydrograph
- **Flood Channel Routing Method:**
  - Muskingum-Cunge, Modified-Puls for Oak Orchard
- **Model Calibration**
  - Historic Events May 2017 and June 2013
- **Flood Frequency Storms: NOAA Atlas 14**
- **Regression analysis developed for validation**



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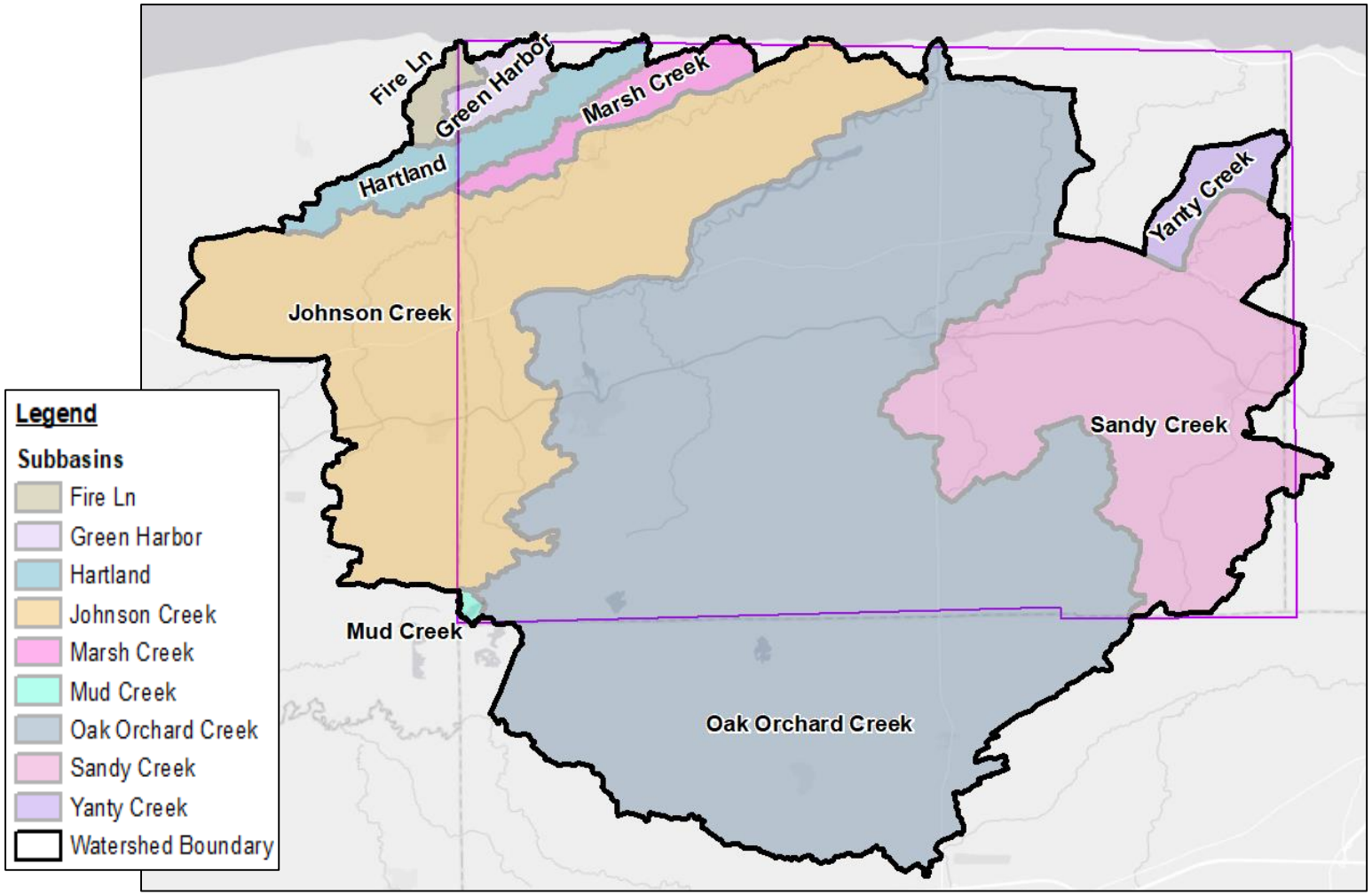
Rainfall-Runoff Modeling
Model Subdivision (based on sub-basins)



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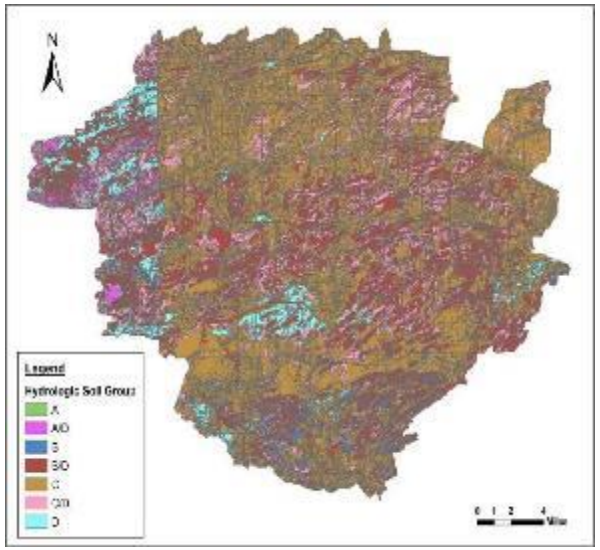
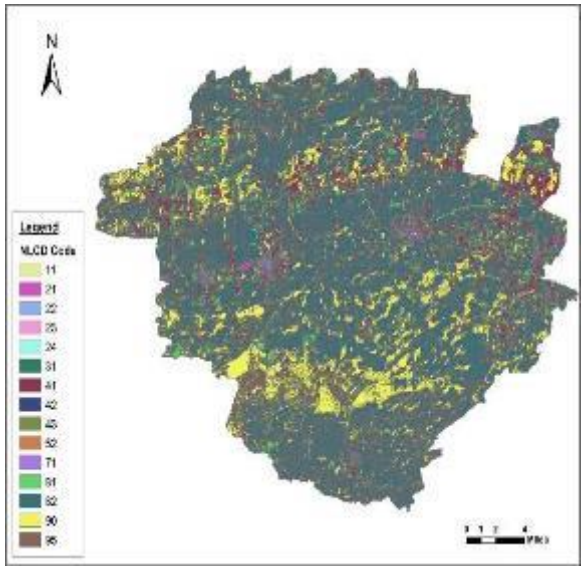
Rainfall-Runoff Modeling
SCS Curve Numbers

- 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)

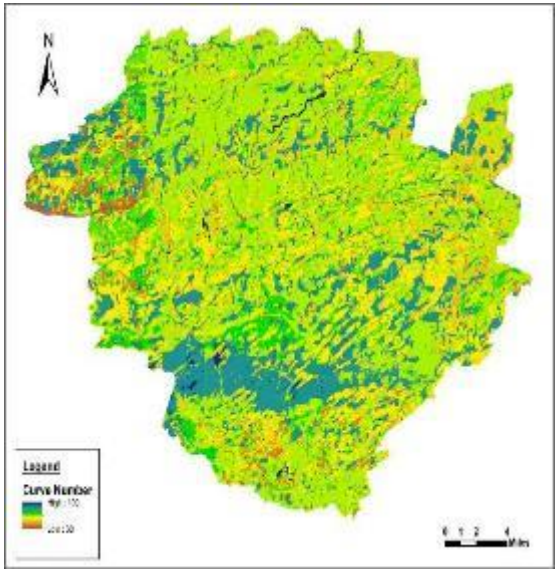
Soils



Land Use

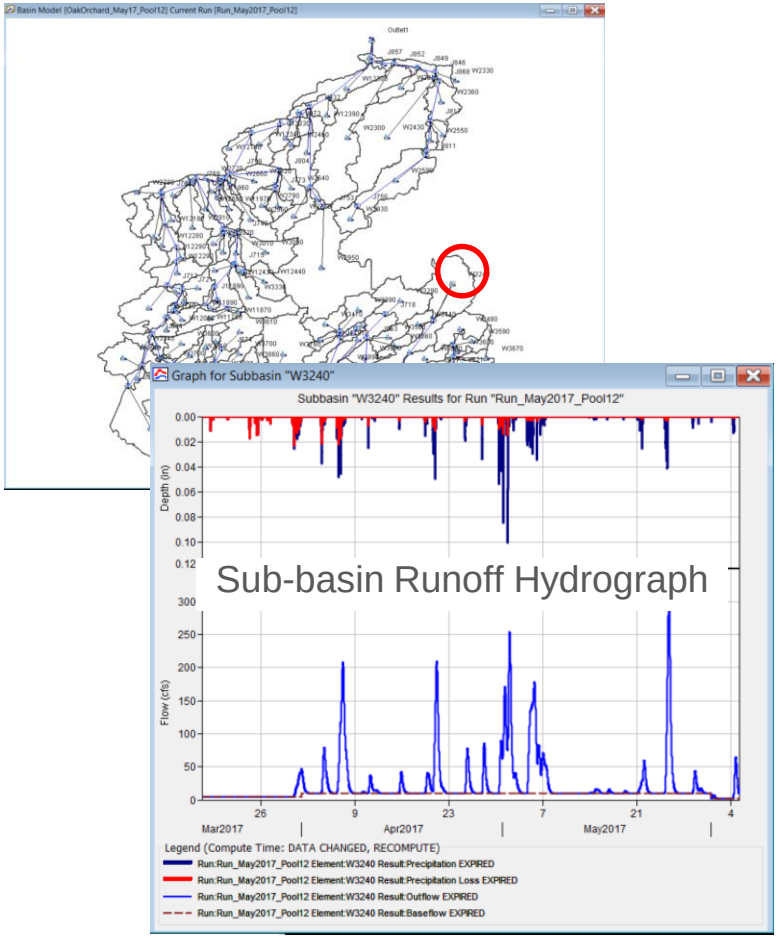


Curve Number



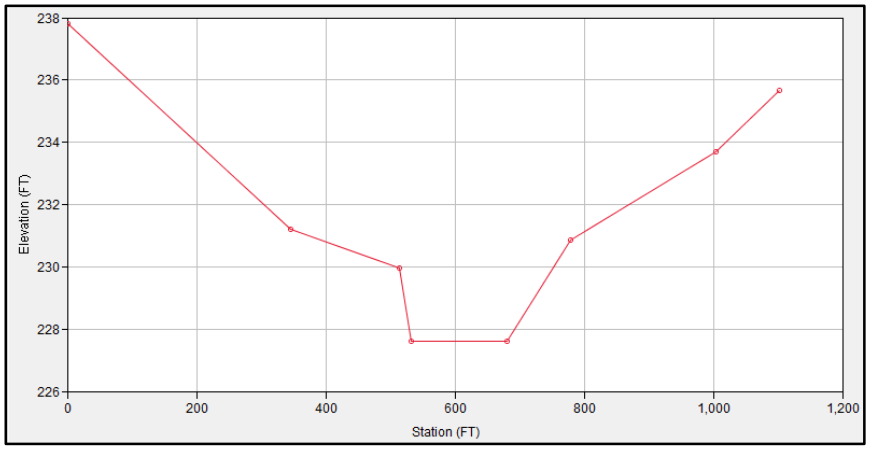
Rainfall-Runoff Modeling
Time of Concentration (Tc) / Lag Time

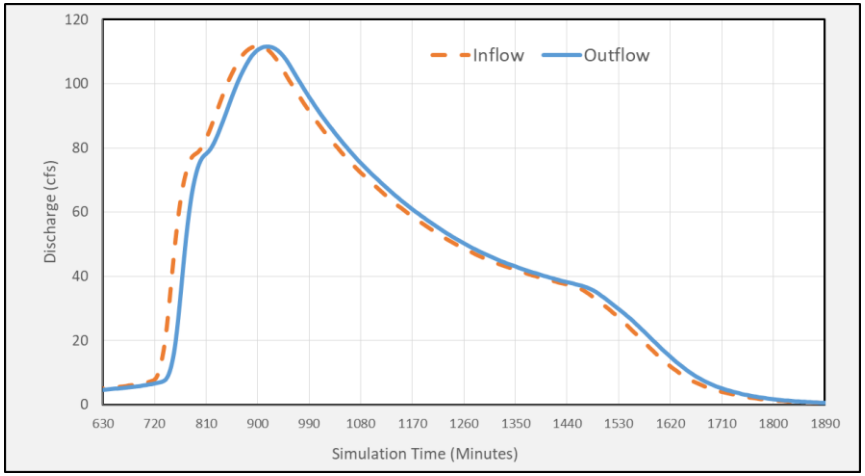
- **Tc = time for runoff to travel from hydraulically distant point to the outlet of a basin or sub-basin**
- **Longest flow paths developed from project DEM**
- **Flow paths split into different types:**
  - Sheet flow maximum = 100 feet
  - Shallow concentrated flow: from end of sheet flow segment 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**



Rainfall-Runoff Modeling
Reach Routing: Method #1 (Muskingum-Cunge)

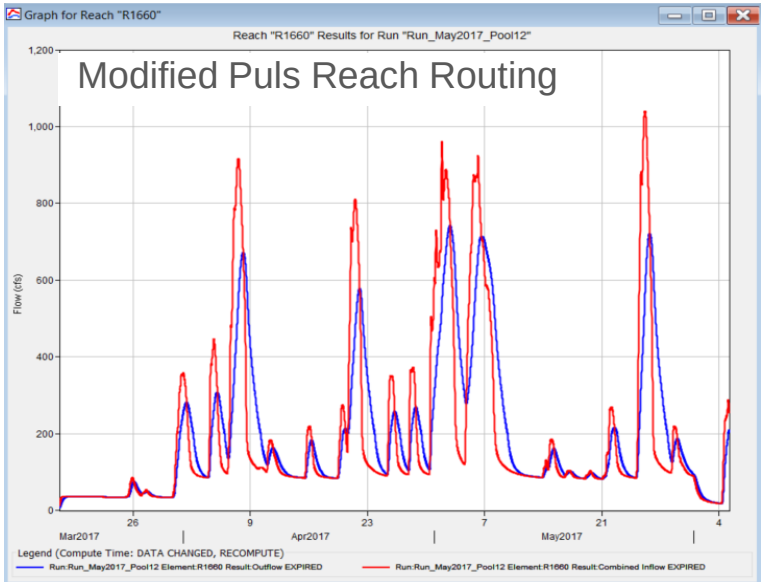
- Applied to all reaches except wetlands reaches in Oak Orchard
- Account for flow attenuation and travel time of flood waves
- Individual sub-basin hydrographs routed downstream along the channels
- Channel cross-sections and other parameters determined from DEM
- Channel roughness determined from imagery

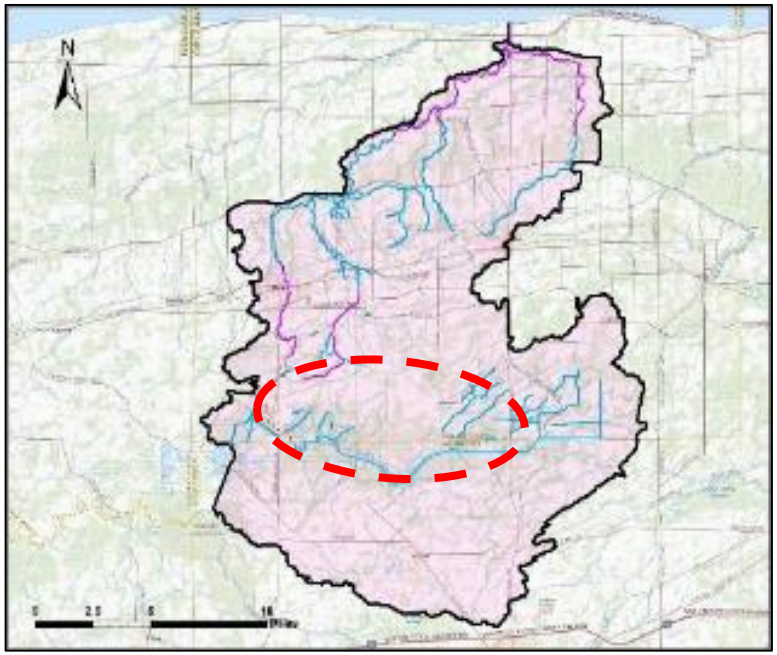




Rainfall-Runoff Modeling
Reach Routing: Method #2 (Modified Puls)

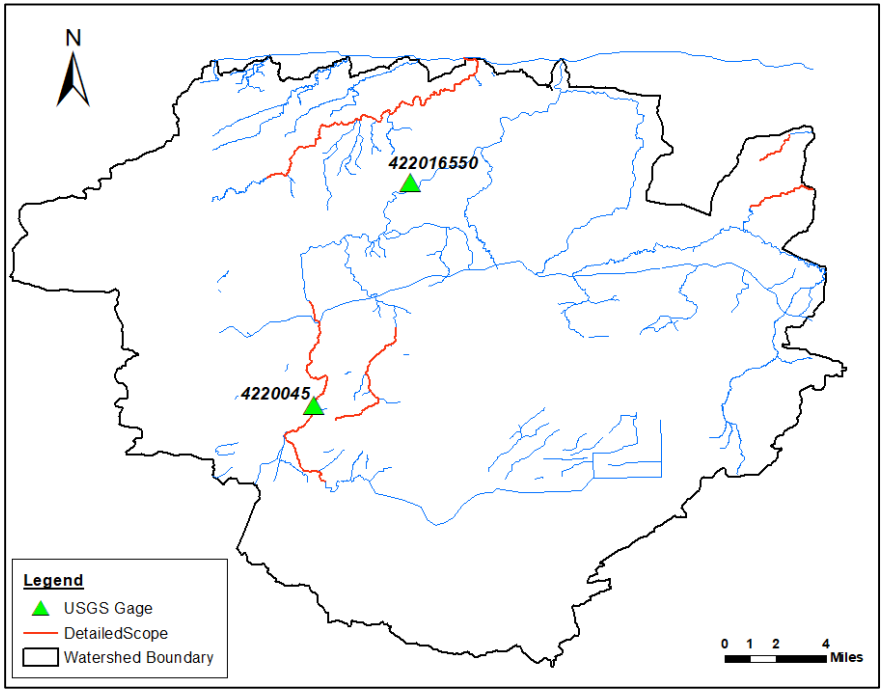
- Oak Orchard wetlands (upper reaches) modeled using Modified Puls Method
- Gage data indicates that upper watershed peaks days after lower watershed
- Wetland acts like flood control system





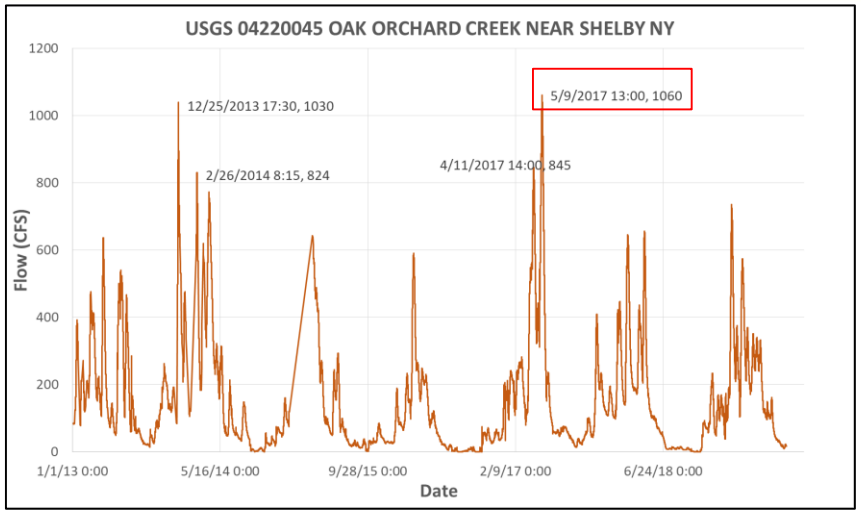
Rainfall-Runoff Modeling
USGS Gages

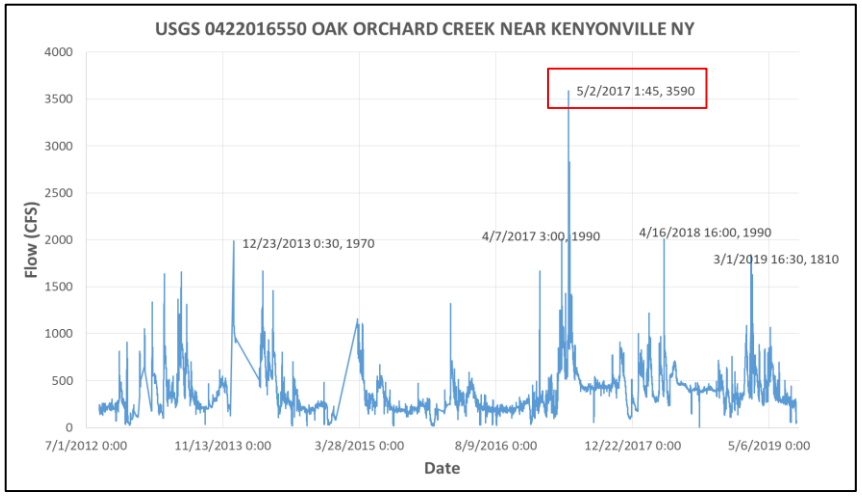
- **Only 2 active gages with gage record of <10 years**
  - Both on Oak Orchard Creek
- **USGS Gage 04220045 (Shelby, NY)**
  - Drainage Area: 146 mi^2
  - Period of Record: 10 Years
- **USGS Gage 0422016550 (Kenyonville, NY)**
  - Drainage Area: 202 mi^2
  - Period of Record: 7 Years
- **Period of record not sufficient for statistical gage analyses**
- **Data used for HEC-HMS model calibration**



Rainfall-Runoff Modeling
Calibration Event Selection

- **Historic storm peak flows analyzed**
- **May 2017 was the highest peak within the period of record**
- **Model calibration was performed using NOAA/NCEP gridded rainfall product used**
  - Quantitative Precipitation Estimate (QPE)
  - QPE is a stage IV calibrated rainfall product
  - Spatial Resolution: 1 Kilometer
  - Temporal Resolution: 1 Hour

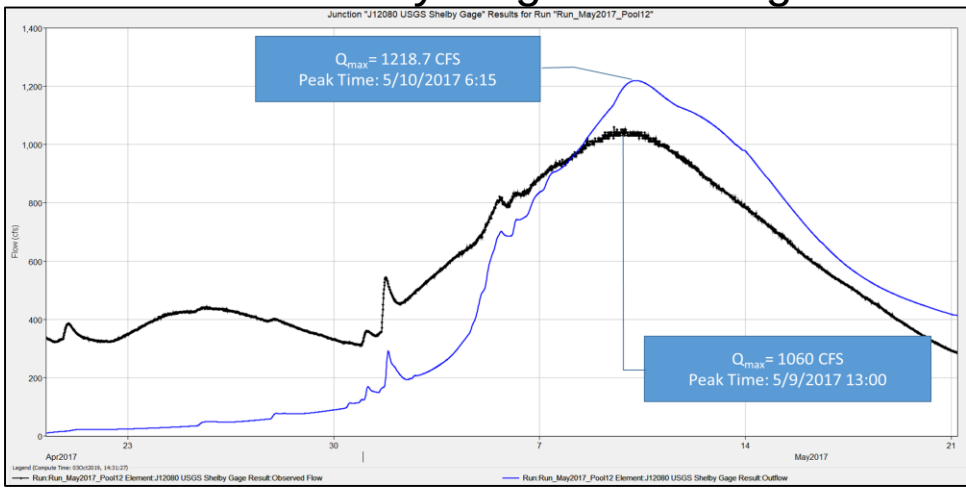




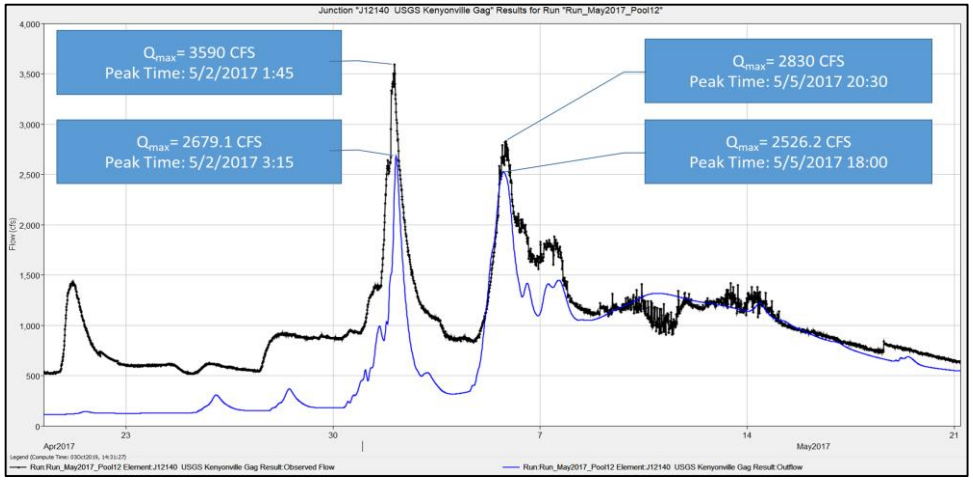
Rainfall-Runoff Modeling
Oak Orchard Creek Calibration and Validation

- Curve numbers and lag times adjusted
- Monthly base flow considered
- Reach routing methods adjusted based on the flow conditions
- Calibration to be improved with 2D hydraulic model for Oak Orchard Creek

USGS Shelby Gage – US Gage



USGS Kenyonville Gage – DS Gage



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Rainfall-Runoff Modeling
Frequency Storm Rainfall Data

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

Simulation Period: 24 Hour

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)

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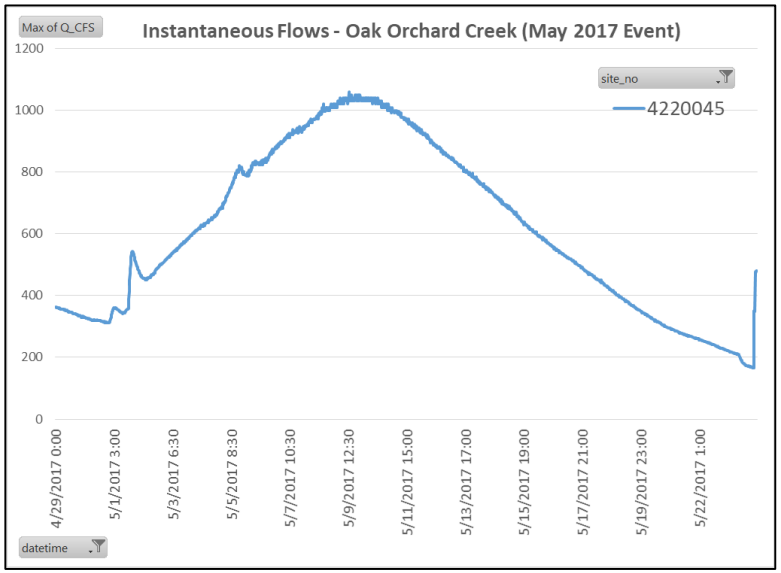
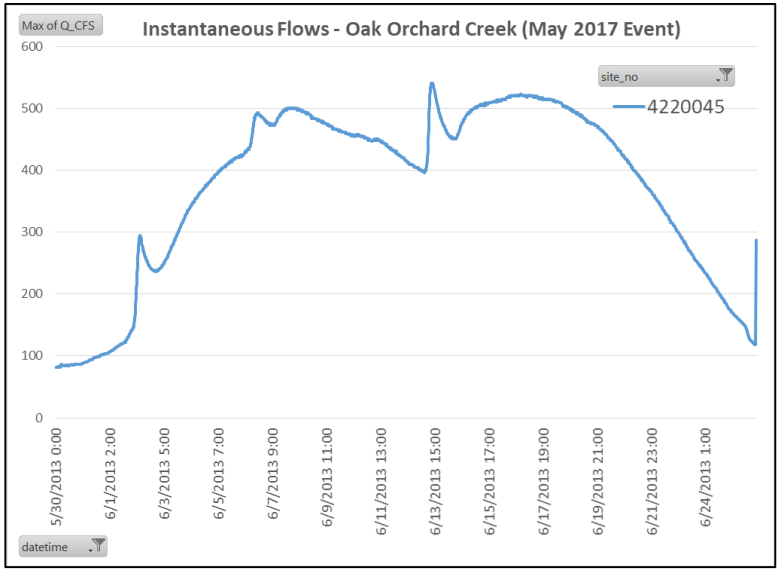
Rainfall-Runoff Modeling
Oak Orchard Creek, Simulation Period





Simulation Period: 10 Days

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	0.265 (0.201-0.346)	0.324 (0.245-0.424)	0.421 (0.317-0.552)	0.502 (0.377-0.662)	0.613 (0.449-0.842)	0.696 (0.502-0.973)	0.785 (0.555-1.14)	0.892 (0.595-1.30)	1.05 (0.680-1.58)	1.19 (0.754-1.82)
10-min	0.375 (0.284-0.490)	0.460 (0.348-0.601)	0.598 (0.452-0.784)	0.712 (0.534-0.937)	0.869 (0.637-1.19)	0.985 (0.711-1.38)	1.11 (0.786-1.61)	1.26 (0.842-1.84)	1.49 (0.963-2.24)	1.69 (1.07-2.57)
15-min	0.442 (0.334-0.577)	0.541 (0.409-0.707)	0.703 (0.530-0.921)	0.837 (0.628-1.10)	1.02 (0.749-1.40)	1.16 (0.837-1.62)	1.31 (0.925-1.90)	1.49 (0.992-2.17)	1.76 (1.13-2.63)	1.99 (1.26-3.03)
30-min	0.612 (0.463-0.799)	0.749 (0.567-0.980)	0.974 (0.735-1.28)	1.16 (0.871-1.53)	1.42 (1.04-1.95)	1.61 (1.16-2.25)	1.81 (1.28-2.63)	2.06 (1.38-3.00)	2.44 (1.57-3.65)	2.76 (1.75-4.20)
60-min	0.782 (0.592-1.02)	0.958 (0.725-1.25)	1.25 (0.940-1.63)	1.48 (1.11-1.95)	1.81 (1.33-2.49)	2.06 (1.48-2.88)	2.32 (1.64-3.36)	2.64 (1.76-3.84)	3.12 (2.01-4.67)	3.53 (2.23-5.37)
2-hr	0.966 (0.740-1.25)	1.18 (0.902-1.53)	1.53 (1.17-1.98)	1.82 (1.38-2.37)	2.22 (1.64-3.01)	2.51 (1.83-3.47)	2.83 (2.02-4.05)	3.21 (2.16-4.63)	3.80 (2.46-5.62)	4.29 (2.73-6.46)
3-hr	1.08 (0.835-1.39)	1.32 (1.01-1.69)	1.70 (1.31-2.19)	2.02 (1.54-2.62)	2.46 (1.83-3.31)	2.79 (2.04-3.83)	3.14 (2.25-4.46)	3.56 (2.40-5.09)	4.20 (2.74-6.18)	4.74 (3.03-7.09)
6-hr	1.31 (1.02-1.66)	1.58 (1.23-2.01)	2.03 (1.57-2.58)	2.40 (1.85-3.06)	2.90 (2.18-3.86)	3.28 (2.42-4.45)	3.69 (2.66-5.18)	4.17 (2.83-5.90)	4.90 (3.21-7.12)	5.51 (3.54-8.15)
12-hr	1.58 (1.24-1.97)	1.88 (1.48-2.36)	2.39 (1.87-3.00)	2.81 (2.19-3.55)	3.38 (2.57-4.44)	3.81 (2.84-5.10)	4.27 (3.10-5.91)	4.81 (3.29-6.72)	5.60 (3.70-8.05)	6.27 (4.04-9.16)
24-hr	1.87 (1.49-2.32)	2.21 (1.76-2.74)	2.76 (2.19-3.43)	3.22 (2.54-4.02)	3.85 (2.95-4.99)	4.32 (3.24-5.70)	4.82 (3.52-6.56)	5.39 (3.72-7.44)	6.22 (4.13-8.83)	6.90 (4.47-9.97)
2-day	2.21 (1.78-2.70)	2.56 (2.07-3.14)	3.14 (2.52-3.86)	3.62 (2.89-4.47)	4.28 (3.31-5.47)	4.78 (3.62-6.21)	5.30 (3.89-7.10)	5.88 (4.09-8.02)	6.70 (4.48-9.41)	7.37 (4.81-10.5)
3-day	2.46 (2.00-2.99)	2.82 (2.29-3.43)	3.41 (2.76-4.16)	3.90 (3.14-4.78)	4.57 (3.56-5.80)	5.08 (3.87-6.55)	5.61 (4.14-7.45)	6.20 (4.33-8.39)	7.03 (4.72-9.79)	7.70 (5.04-10.9)
4-day	2.67 (2.18-3.23)	3.04 (2.48-3.68)	3.64 (2.96-4.42)	4.14 (3.35-5.05)	4.83 (3.77-6.09)	5.35 (4.09-6.86)	5.90 (4.36-7.78)	6.49 (4.55-8.74)	7.33 (4.93-10.2)	8.01 (5.25-11.3)
7-day	3.20 (2.64-3.83)	3.60 (2.97-4.32)	4.26 (3.50-5.13)	4.81 (3.93-5.81)	5.56 (4.38-6.93)	6.14 (4.72-7.78)	6.73 [illegible]	7.35 (5.19-9.80)	8.21 (5.56-11.3)	8.89 (5.86-12.4)
10-day	3.69 (3.07-4.40)	4.13 (3.43-4.92)	4.85 (4.01-5.80)	5.45 (4.47-6.54)	6.27 (4.96-7.76)	6.90 (5.33-8.67)	7.54 (5.61-9.72)	8.20 (5.81-10.9)	9.09 (6.18-12.4)	9.78 (6.46-13.6)
20-day	5.20 (4.37-6.11)	5.74 (4.82-6.75)	6.62 (5.54-7.82)	7.36 (6.12-8.73)	8.37 (6.69-10.2)	9.16 (7.14-11.3)	9.94 (7.44-12.6)	10.7 (7.65-14.0)	11.7 (8.01-15.7)	12.4 (8.26-17.0)
30-day	6.46 (5.47-7.55)	7.08 (5.99-8.28)	8.10 (6.82-9.49)	8.94 (7.48-10.5)	10.1 (8.12-12.2)	11.0 (8.61-13.5)	11.9 (8.92-14.9)	12.7 (9.14-16.5)	13.8 (9.48-18.4)	14.5 (9.70-19.8)
45-day	8.06 (6.87-9.34)	8.77 (7.47-10.2)	9.92 (8.42-11.5)	10.9 (9.17-12.7)	12.2 (9.87-14.6)	13.2 (10.4-16.1)	14.2 (10.7-17.7)	15.2 (10.9-19.5)	16.3 (11.2-21.6)	17.1 (11.4-23.1)
60-day	9.41 (8.07-10.8)	10.2 (8.72-11.7)	11.4 (9.76-13.2)	12.5 (10.6-14.5)	13.9 (11.3-16.6)	15.1 (11.9-18.2)	16.2 (12.2-20.0)	17.1 (12.4-21.9)	18.3 (12.7-24.1)	19.1 (12.8-25.7)

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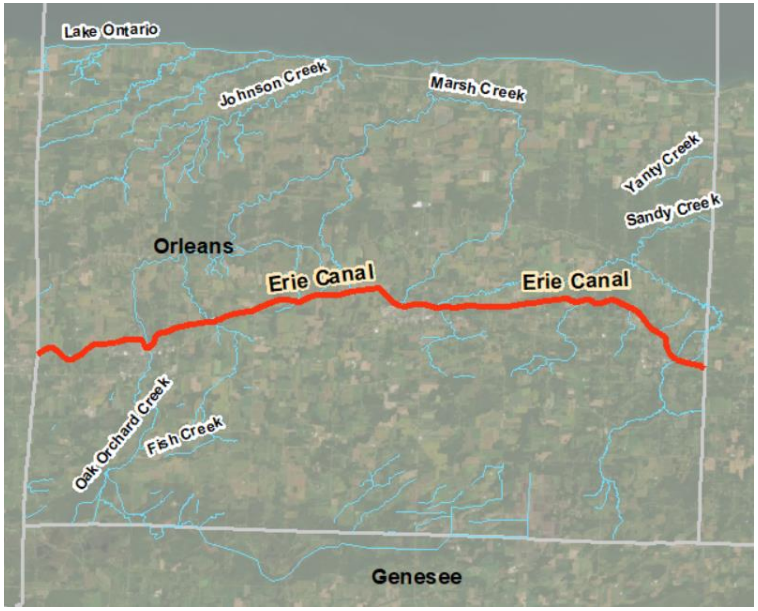
Erie Canal Hydrologic Analysis

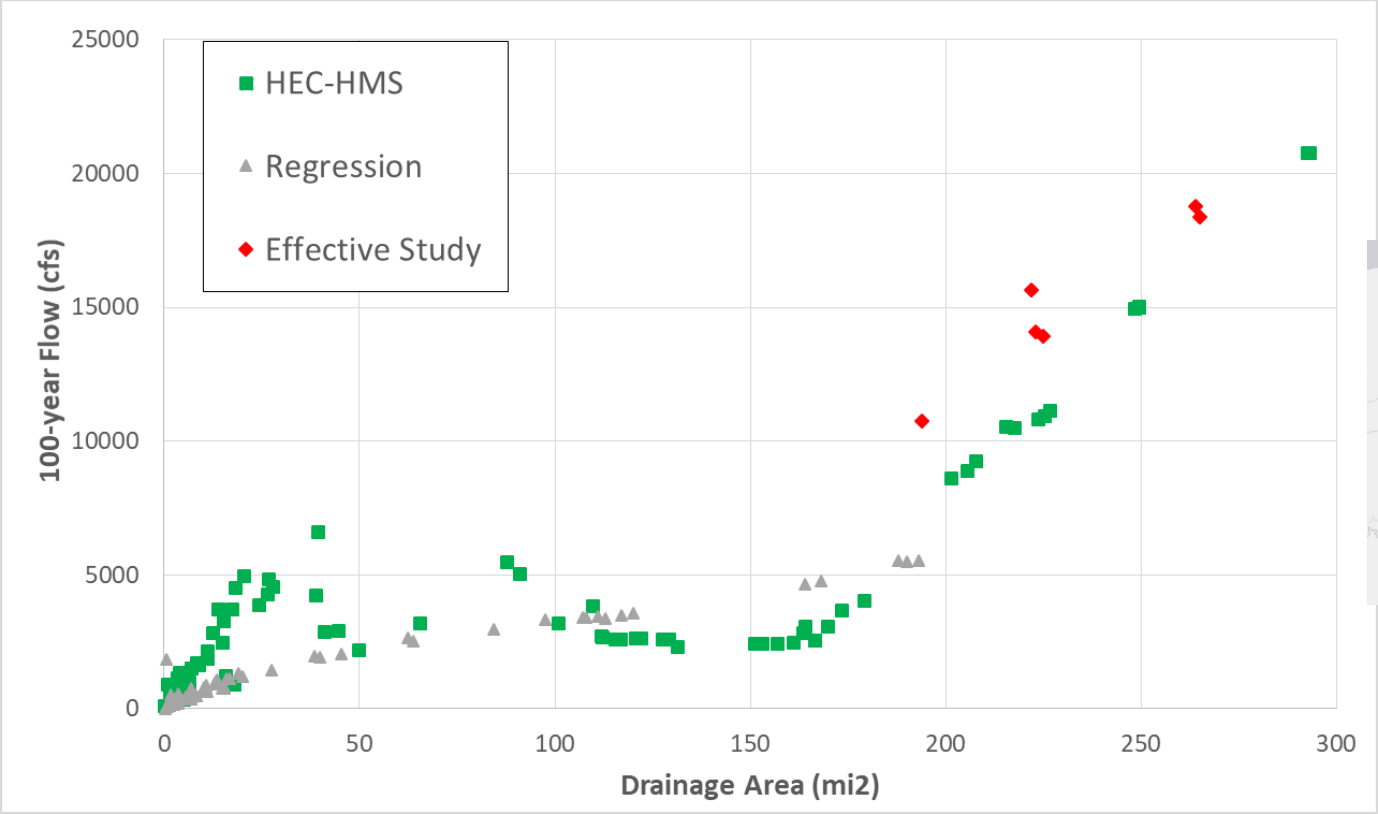
- Approximately 26 miles running through Orleans County
- Navigation season: May 1st to November 15th
- Regulated by a sluice gate structure in Lockport, NY
- Typical flow rate is approximately 1250 cfs (NY Power Authority)
- The canal is drained by mid-November and remains at a lower water level until April 30th.
- Constant flow rate of 1250 cfs was used for the analyses

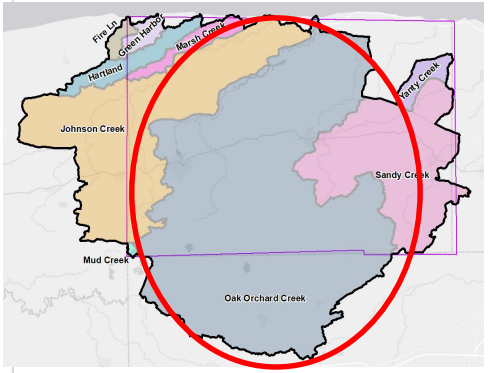


Detailed Studies – Draft Discharges

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (mi^2)	PEAK DISCHARGES (cfs)				
		10-YEAR	25-YEAR	50-YEAR	100-YEAR	500-YEAR
Johnson Creek						
At mouth	112.7	2,178	3,481	4,632	4,976	12,699
Sandy Creek						
At mouth	77.5	2,777	4,403	5,987	7,887	14,420
Yanty Creek						
At mouth	6.6	260	464	520	656	1,067
Oak Orchard						
At downstream scope limit	153.0	1,143	1,659	2,018	2,409	3,625
Fish Creek						
At mouth	20.5	1,345	2,047	4,179	4,958	5,384

Comparison of Results
Oak Orchard Creek Watershed





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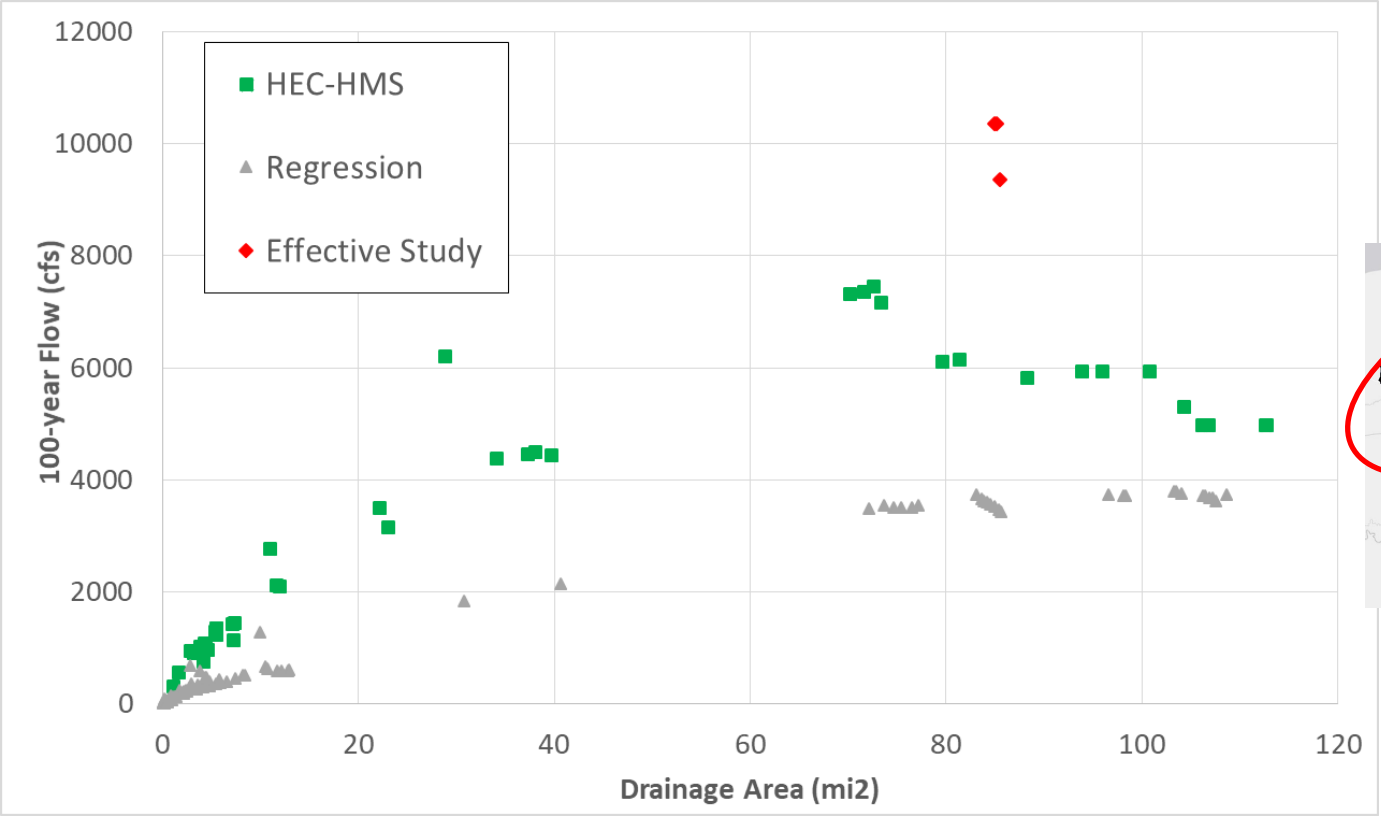
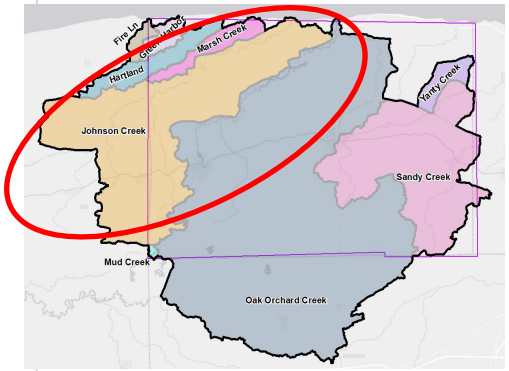
Comparison of Results
Johnson Creek Watershed





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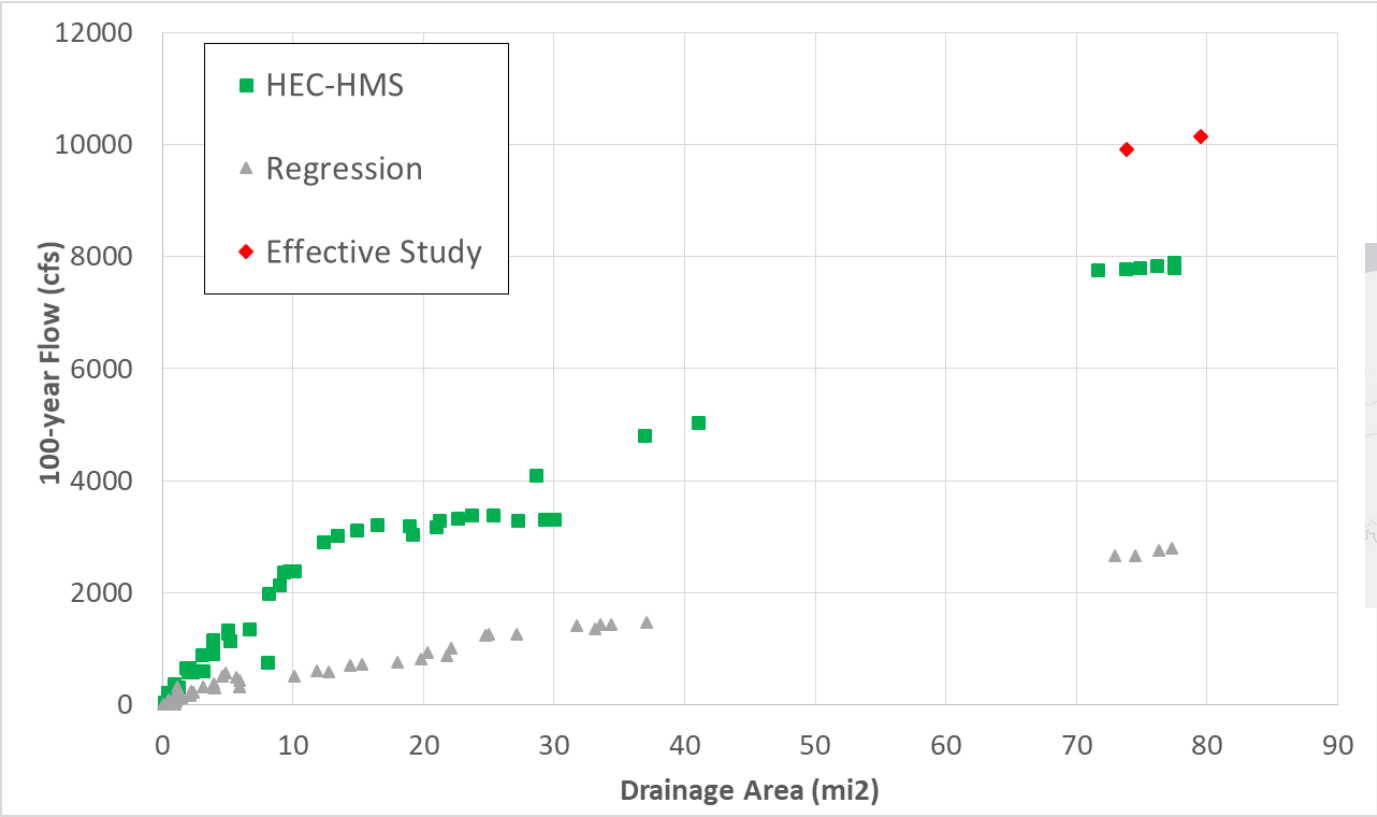
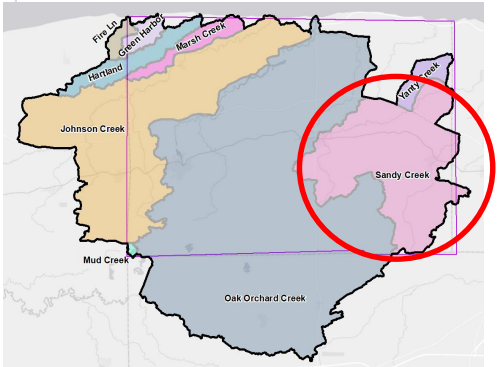
Comparison of Results
Sandy Creek Watershed





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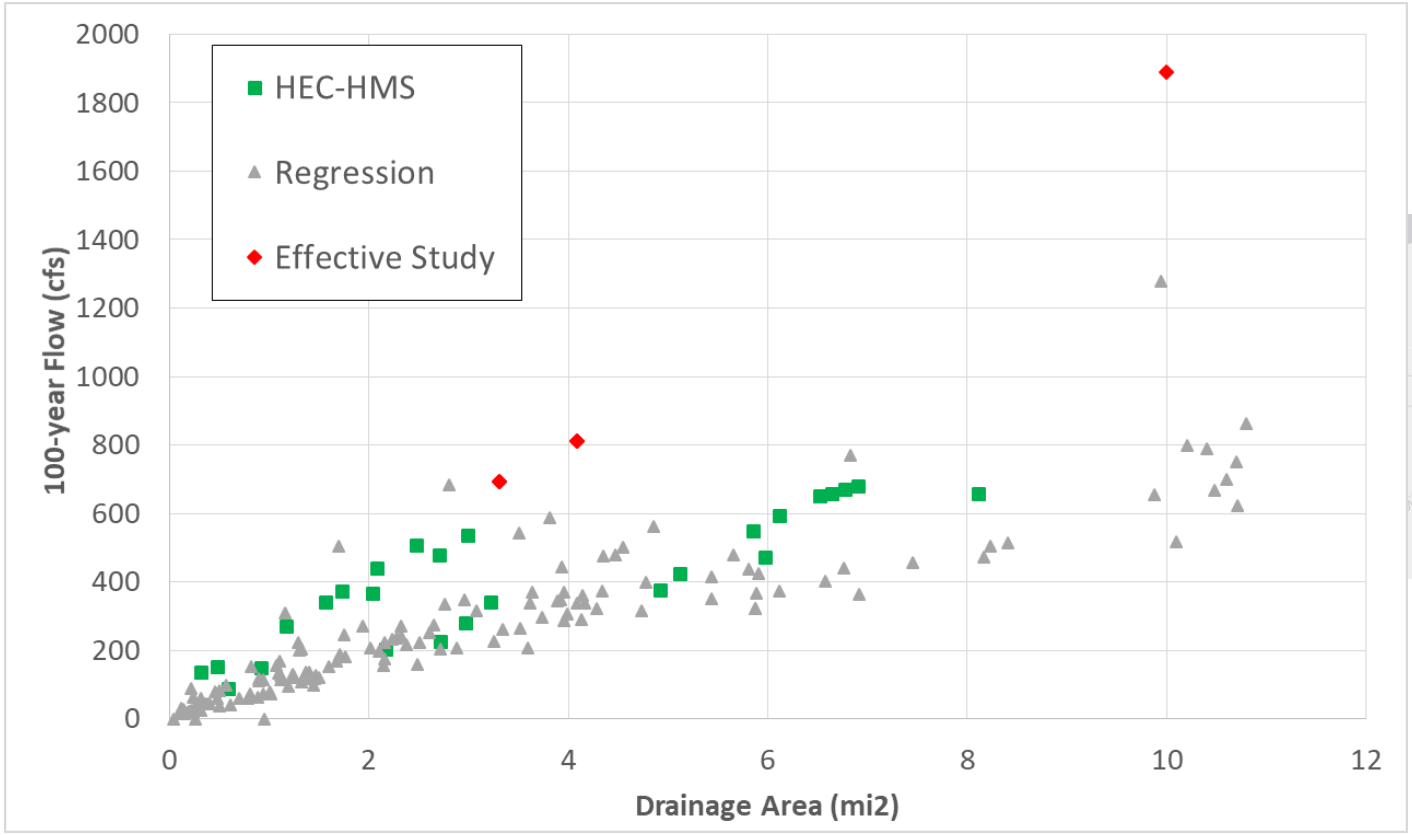
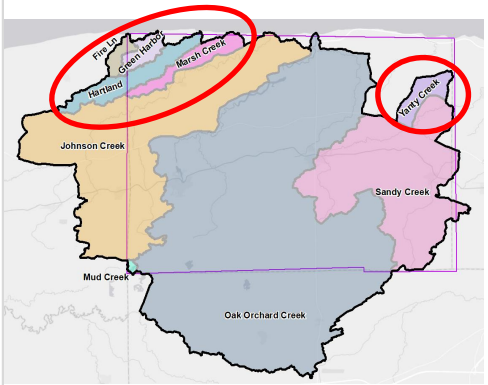
Comparison of Results

Yanty Creek, Marsh Creek, Hartland, Grand Harbor, Fire Ln





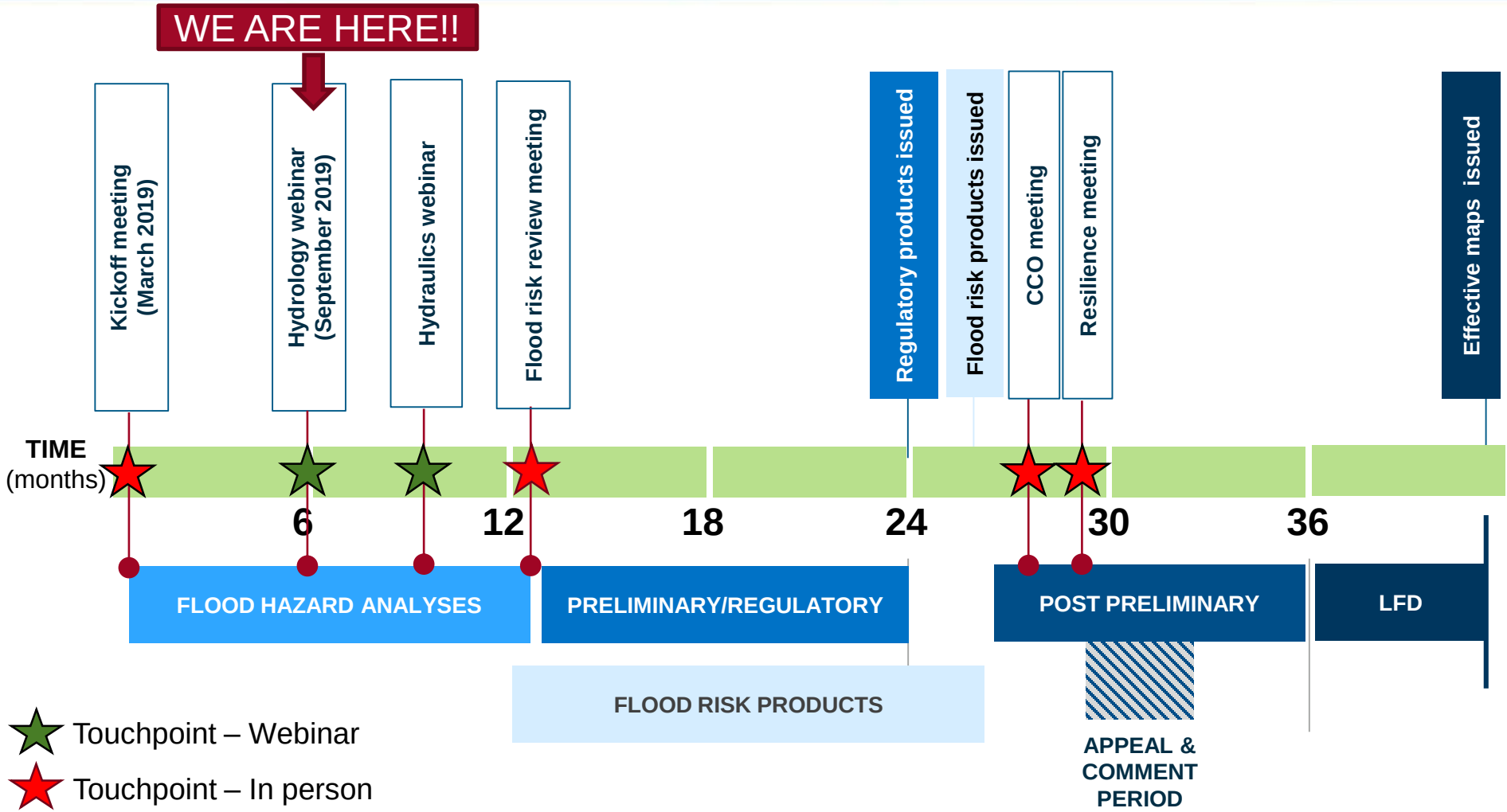
Overview of Results

- Methodology utilized consistent with the effective study, which is rainfall-runoff modeling
- Model discharges are generally lower than effective study
- Model discharges are generally higher than regression based
- Oak Orchard model will be improved under the hydraulic analyses phase
- Erie canal discharges are regulated and constant.

Next Steps

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

Overall Flood Risk Project Timeline



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Questions? Comments?

Thank you!

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