Flood Risk Project

Genesee County, New York

Hydrology Review Meeting

September 21, 2021

FEMA

Agenda

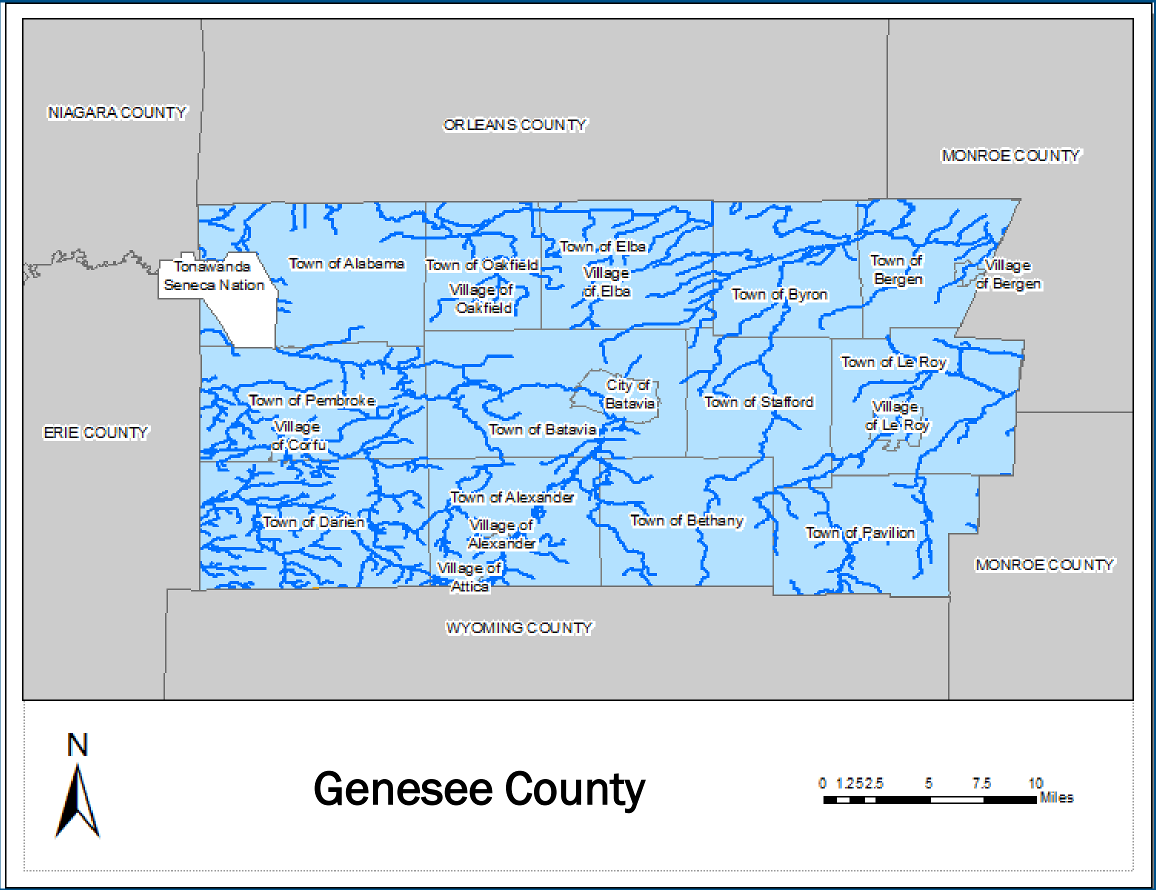
Recap/Refresh

Hydrology Analysis Review

Path Forward

Project Recap

- **Projects in Genesee County**
  - Lake Ontario – Lower Genesee Watersheds Discovery
    - Meeting held Nov 2013
    - Completed in July 2016
- **Current Genesee Study Progress**
  - Kickoff meeting: Held virtually January 21, 2021
  - Engineering models notification: February 17, 2021
  - Field survey: Completed
  - Hydrologic analysis: June 2021 – Present



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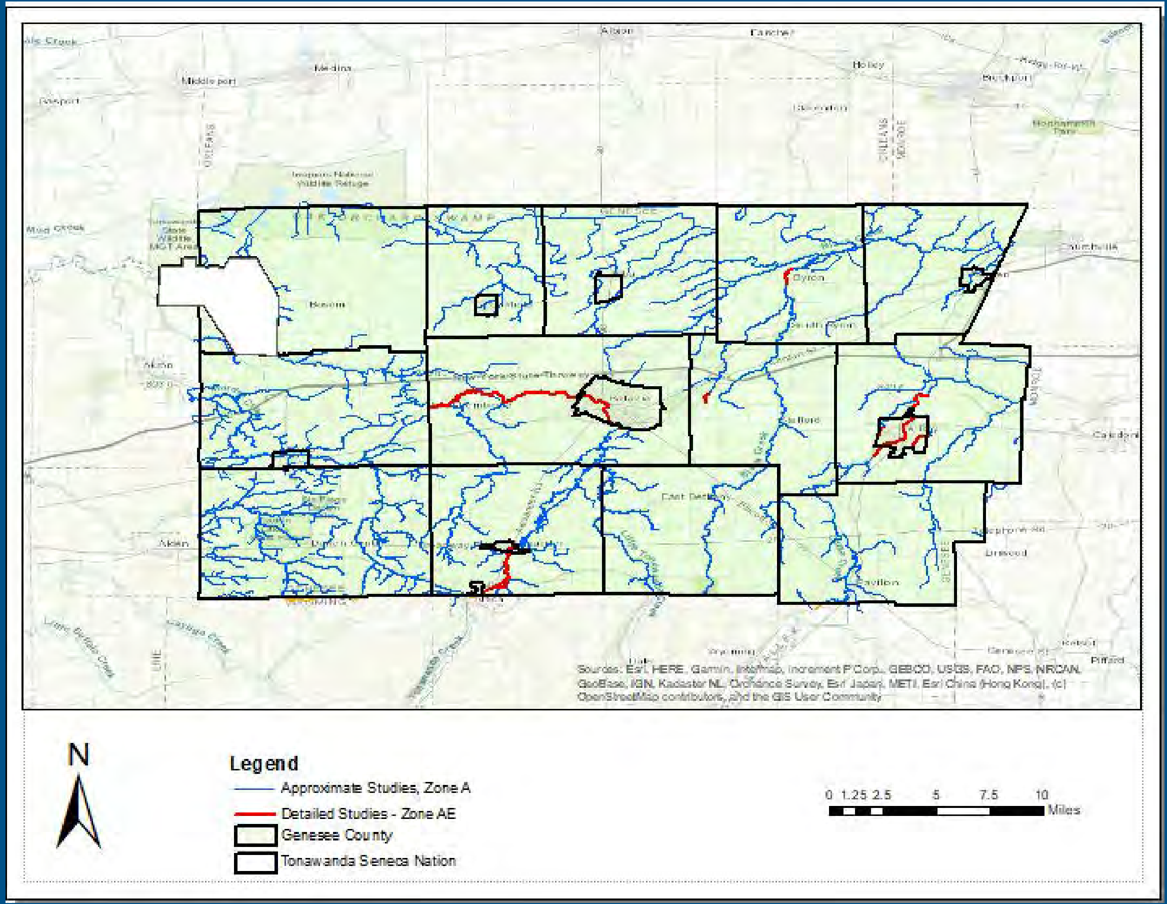
Project Scope

- First time digital maps
- Flooding sources analyzed
  - Detailed riverine studies (AE) – 6 streams, 22 miles
  - Detailed lake studies (AE) – 1 Lake, 1.3 miles
  - Approximate studies (A) – multiple streams, 588 miles
- 21 Updated Communities – 110 Map Panels
- Review Meetings
  - Hydrology Meeting
  - Hydraulics Meeting
  - Flood Risk Review Meeting



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Hydrologic Analysis Methods

- Typical Methods FEMA utilizes
  - Statistical Gage Analyses
  - Regression Analyses
  - Rainfall Runoff Modeling
- Discharges developed for
  - 10%, 4%, 2%, 1%, 1%+, 1%-, 0.2%
  - Inputs for hydraulic analyses

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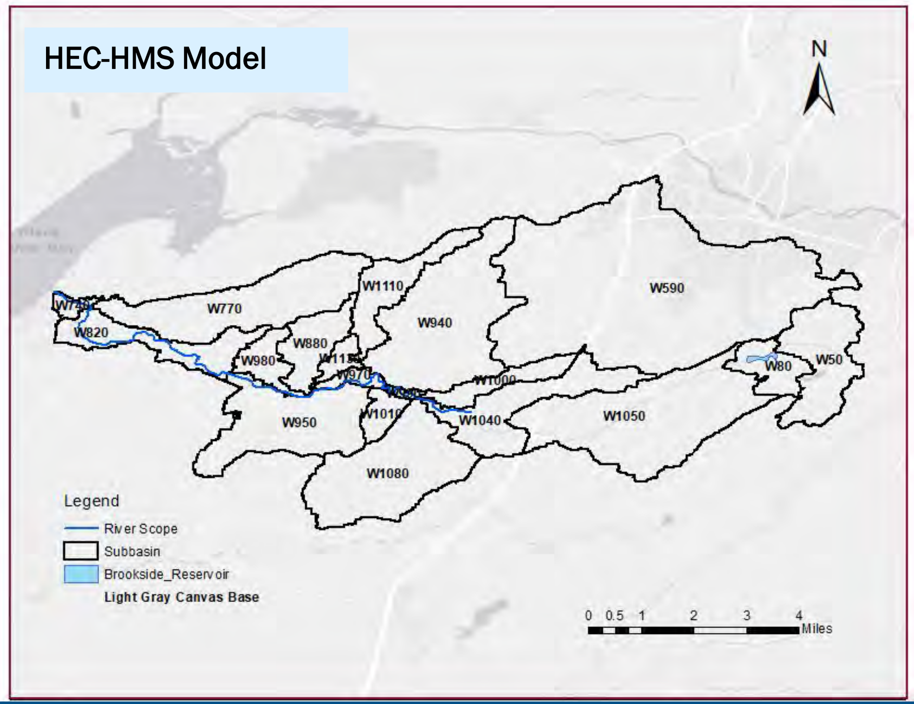
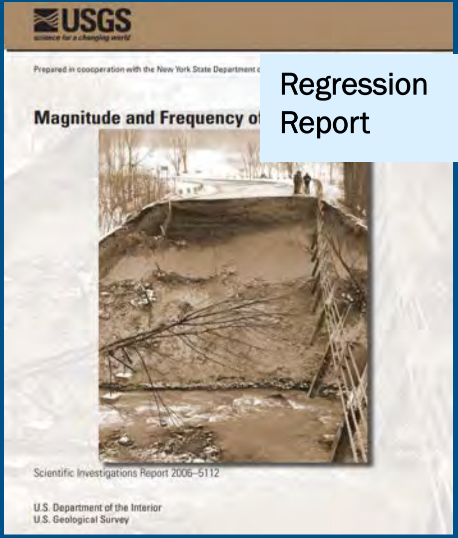
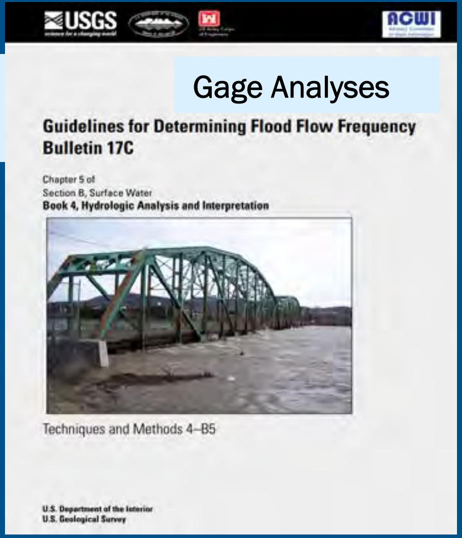




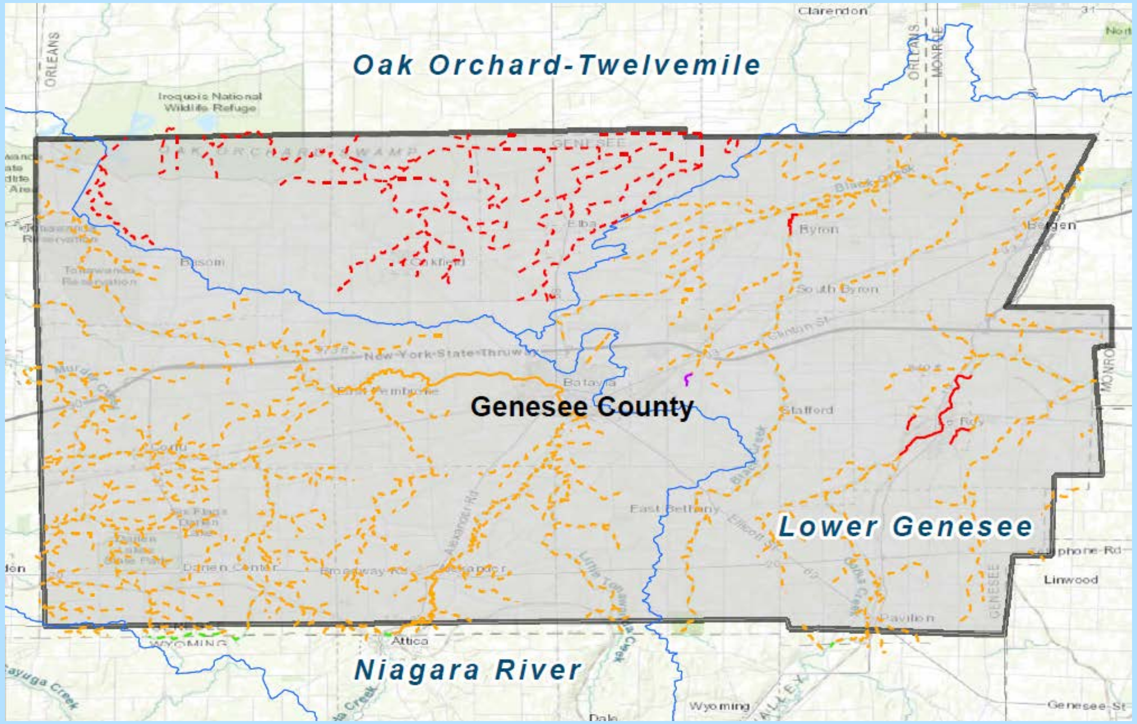


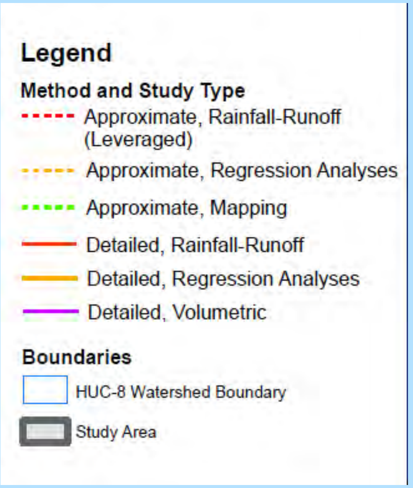
Regression Analysis

- USGS Stream Stats Discharges
- Relationships between peak flows and watershed characteristics
- Regional Regression Equations
- Urban Regression Equations

Hydrology – Regression Analysis

- Regression Analysis = Orange
  - 15 miles of Detailed streams (AE Zone)
  - 588 miles of Approximate streams (A Zone)





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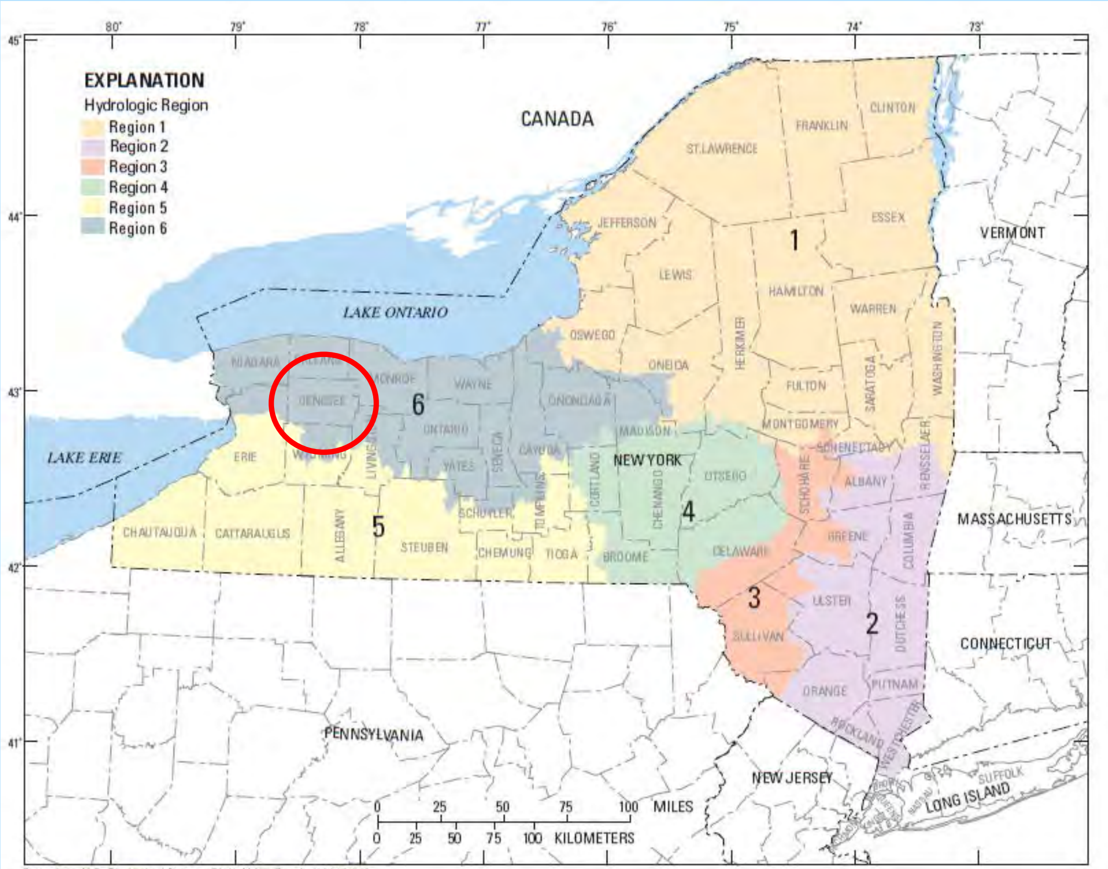
Hydrology – Regression Analysis

- USGS New York regression equations
  - SIR 2006-5112

- Study area falls within USGS NY regression Region 6

- USGS StreamStats v5.02 p7



Base from U.S. Geological Survey, Digital Line Graph, 1:2,000,000
Universal Transverse Mercator projections, zone 18, NAD83

Figure 2. Six hydrologic regions of New York and locations of 388 streamflow-gaging stations represented in this study. (Map numbers refer to streamflow-gaging stations shown in tables 7 and 8.)

Summary of Regression Equations

$$Q_2 = 8.98A^{0.807}(ST + 0.5)^{-0.258}(RUNF)^{0.740}(EL12 + 1)^{0.093}(SR)^{0.209} \quad (4.1)$$

$$Q_{10} = 23.4A^{0.810}(ST + 0.5)^{-0.218}(RUNF)^{0.600}(EL12 + 1)^{0.133}(SR)^{0.268} \quad (4.2)$$

$$Q_{25} = 32.1A^{0.815}(ST + 0.5)^{-0.200}(RUNF)^{0.555}(EL12 + 1)^{0.148}(SR)^{0.290} \quad (4.3)$$

$$Q_{50} = 39.0A^{0.819}(ST + 0.5)^{-0.188}(RUNF)^{0.528}(EL12 + 1)^{0.157}(SR)^{0.305} \quad (4.4)$$

$$Q_{100} = 46.0A^{0.823}(ST + 0.5)^{-0.177}(RUNF)^{0.505}(EL12 + 1)^{0.166}(SR)^{0.318} \quad (4.5)$$

$$Q_{500} = 62.7A^{0.834}(ST + 0.5)^{-0.155}(RUNF)^{0.466}(EL12 + 1)^{0.183}(SR)^{0.345} \quad (4.6)$$

where

Q_x = peak flow for x-year storm event (cubic feet per second)

A = drainage area (square miles)

ST = basin storage (percentage of total drainage area)

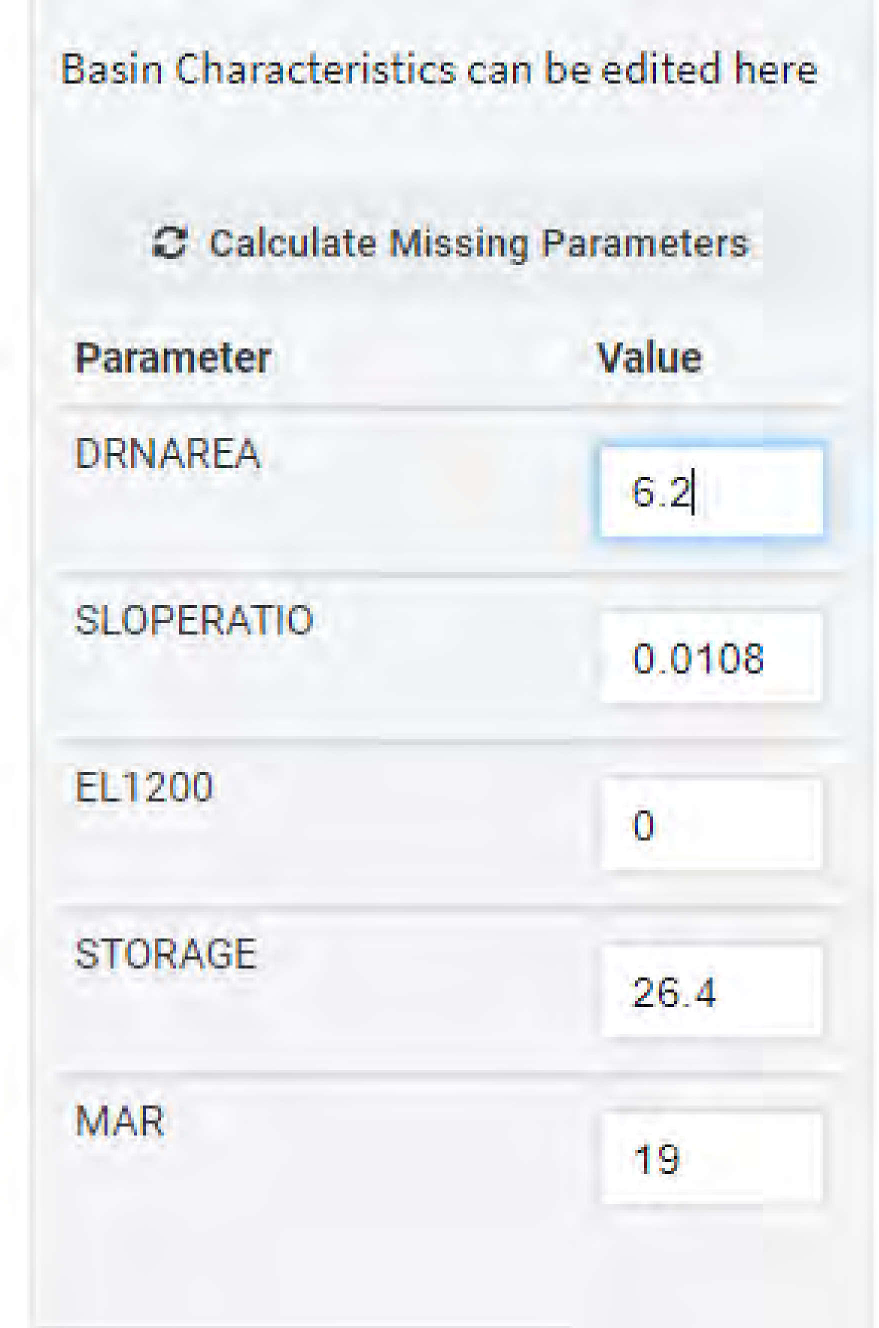
RUNF = mean annual runoff (inches)

EL12 = percentage of drainage basin at or greater than 1,200 feet above sea level

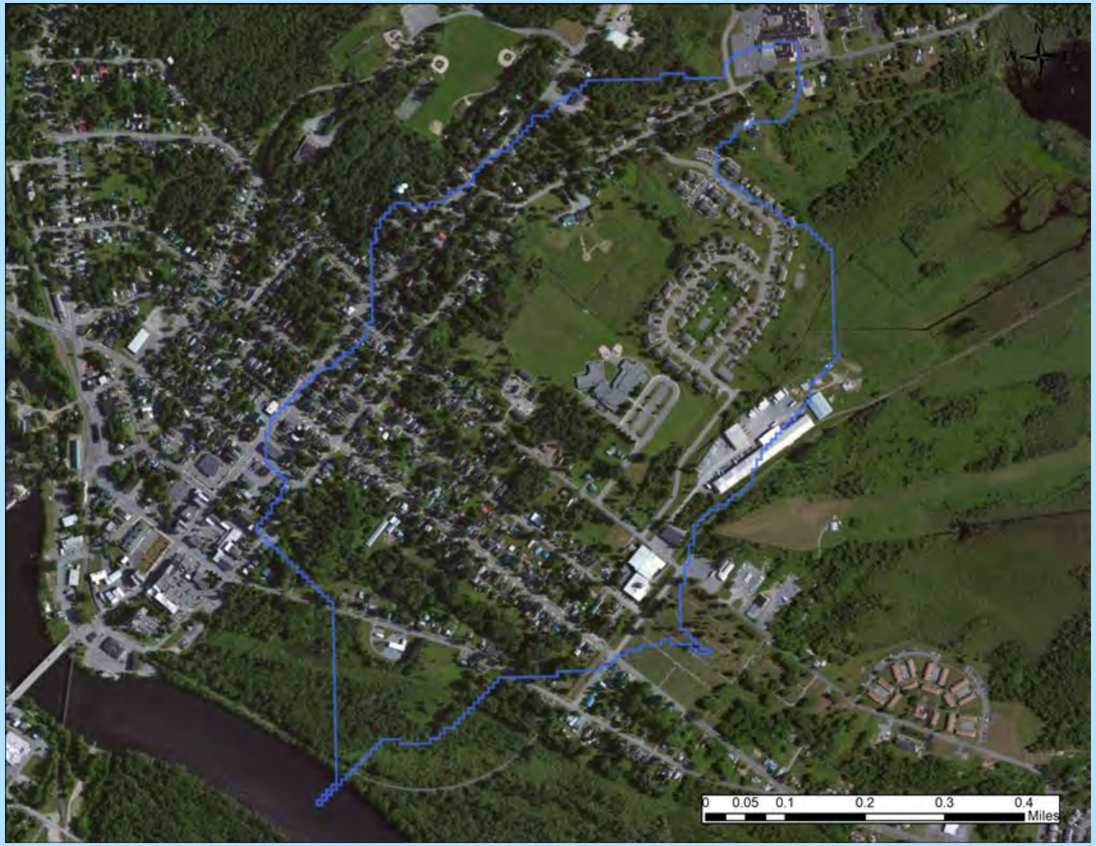
SR = ratio of main-channel slope to basin slope within the drainage basin

Manual Basin Adjustments

- Reviewed StreamStats basin delineations against project DEM
- Adjusted basin boundaries as necessary within GIS
- StreamStats used to manually update drainage area parameter and re-compute flow results
  - Other parameters were assumed to be unchanged

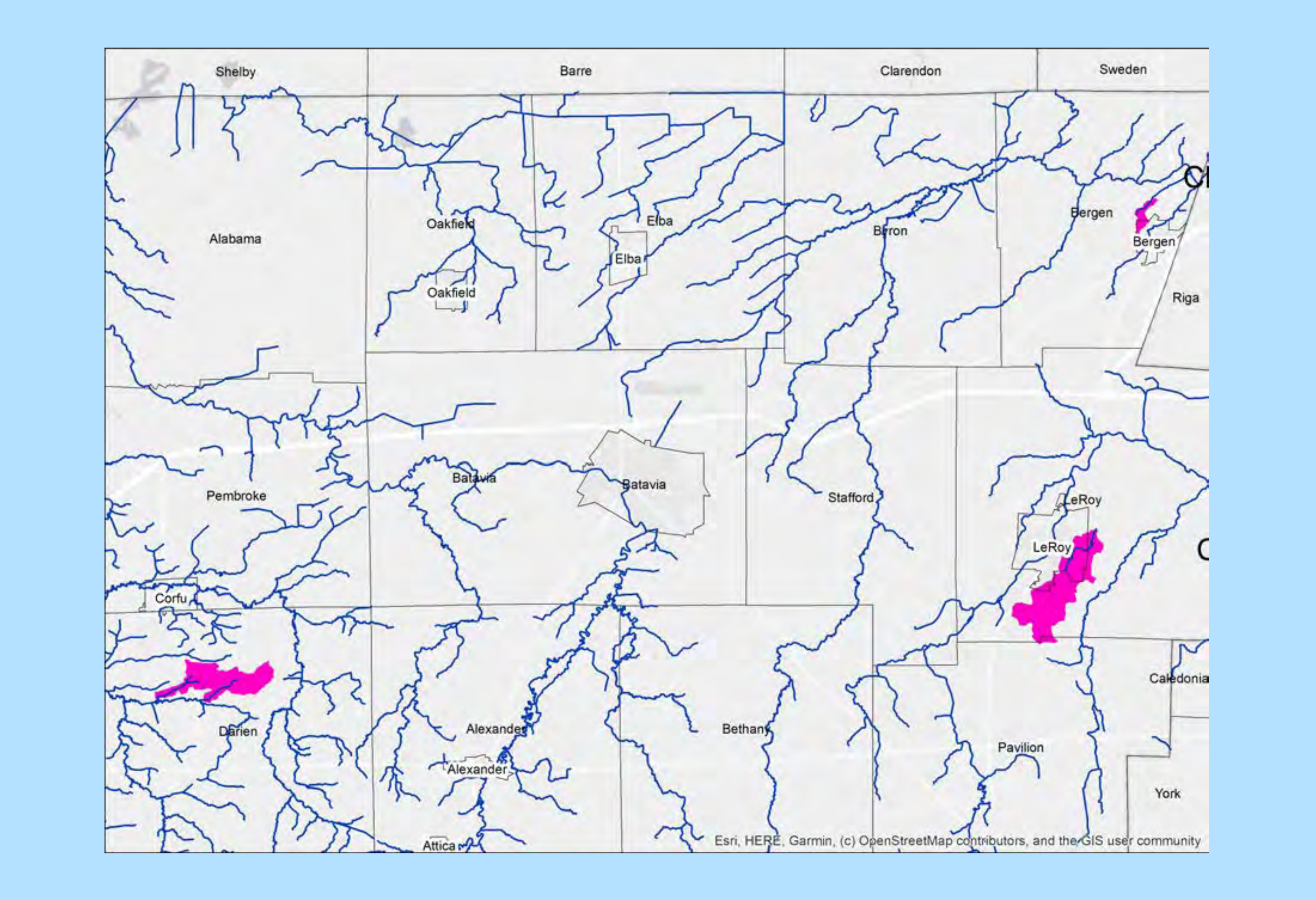


Urban Adjustment



- Base regression equations not applicable to urban areas
- Peak flows adjusted for basins with >15% urban land use (from NLCD layer) based on USGS WSP 2207 (1983)
- Affected Reaches:
  - Mud Creek Tributary 2, Crooked Creek Tributary 2, Crooked Creek Tributary 3, and Black Creek Tributary 3

Urban Adjustment Factor – Basin Level View

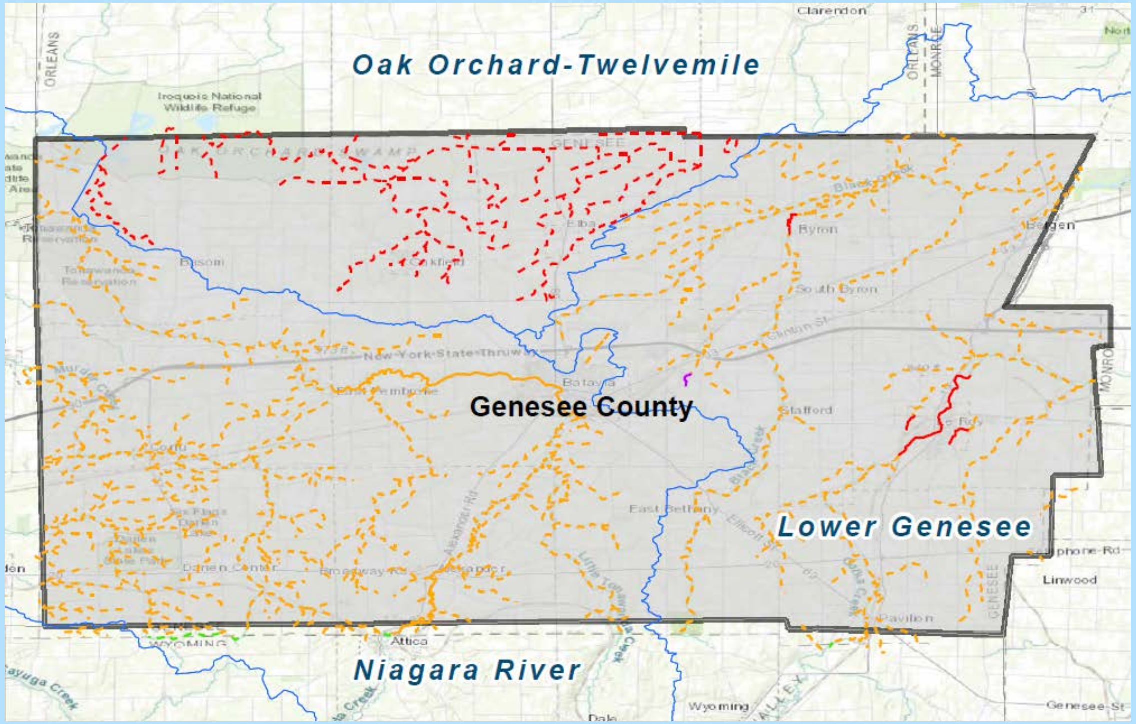


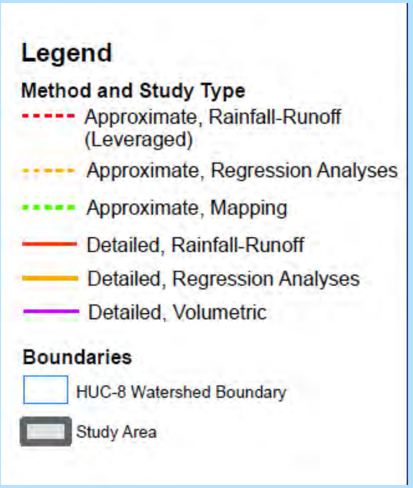
Rainfall-Runoff Analysis

- Creation of hydrologic models to calculate flows at outlet, node or subbasin
- Various inputs required
- Typically used for detailed studies

Hydrology – Rainfall-Runoff Modeling

- Rainfall-Runoff = Red
- 98 miles leveraged from Upper Oak Orchard Watershed study (Ontario Countywide, 2020)
- New study: total 4 streams (7 miles)
  - Mud Creek Tributary 2
  - Black Creek
  - Oatka Creek
  - Oatka Creek Tributary
- Horseshoe Lake
  - Scoped to be studied using stage frequency analysis.
  - No gage data – HEC-HMS rainfall runoff model used to estimate frequency stages.





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Rainfall-Runoff Methodology

- HEC-HMS 4.5 was used
- Rainfall Depths: NOAA Atlas 14 Precipitation Frequency Data Server, 24-hour duration.
- Frequency Storm temporal distribution
- Loss Methodology: SCS Curve Number (TR-55), with average antecedent runoff condition
- Hydrograph Methodology: SCS Unit Hydrograph
  - Lag Time (60% of Time of Concentration)
- Channel Routing: Muskingum-Cunge using 8-point cross-sections
- Reservoir Routing: Stage-Storage curve developed from project topography

NOAA Atlas 14 Rainfall Data

- Area Reduction Factors were applied as appropriate for watersheds greater than 10 sq. mi

Cumulative 24-Hour Rainfall Depth (inches)						
Site	50%-Annual Chance	10%-Annual Chance	4%-Annual Chance	2%-Annual Chance	1%-Annual Chance	0.2%-Annual Chance
Linden Station	2.27	3.30	3.94	4.41	4.92	6.48
Black Creek Watershed	2.16	3.14	3.75	4.19	4.68	6.16
Mud Creek Tributary 2 Watershed	2.27	3.30	3.94	4.41	4.92	6.48
Oatka Creek Watershed	2.12	3.08	3.67	4.11	4.59	6.04

2-7

TABLE 2-3

PRINCIPAL SPILLWAY VOLUME ADJUSTMENTS

A. Minimum Areal Adjustment Ratios for Precipitation

Area Sq. Mi.	Area/Point Ratio for: 1 Day	Area/Point Ratio for: 10 Days	Area Sq. Mi.	Area/Point Ratio for: 1 Day	Area/Point Ratio for: 10 Days
10. or less	1.000	1.000	45.	0.951	0.976
15.	0.977	0.991	50.	0.948	0.974
20.	0.969	0.987	60.	0.944	0.972
25.	0.965	0.983	70.	0.940	0.970
30.	0.961	0.981	80.	0.937	0.969
35.	0.957	0.979	90.	0.935	0.967
40.	0.954	0.977	100.	0.932	0.966

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Rainfall-Runoff Modeling – SCS Curve Numbers

- Soil Data from USGS SSURGO database
- Land use data from National Land Use Database (NLCD)
- Composite CN calculated for each sub-basin (TR-55 Methodology)
- Land use compared to recent aerial imagery to confirm
- Calculated composite Curve Numbers range from 67-85

Table 2-2a Runoff curve numbers for urban areas [1/]

Cover description: Cover type and hydrologic condition	Cover description: Average percent impervious area [2/]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89

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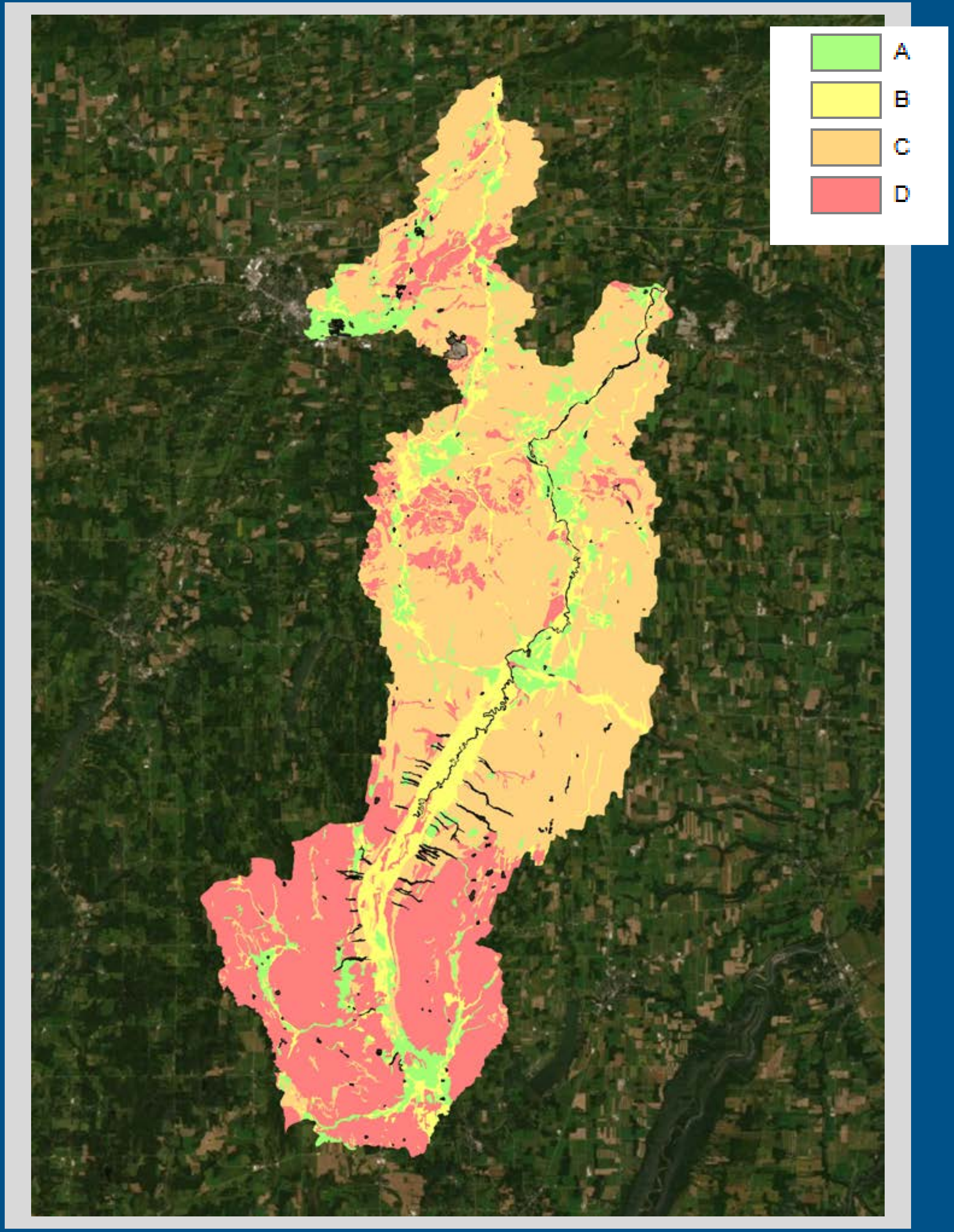
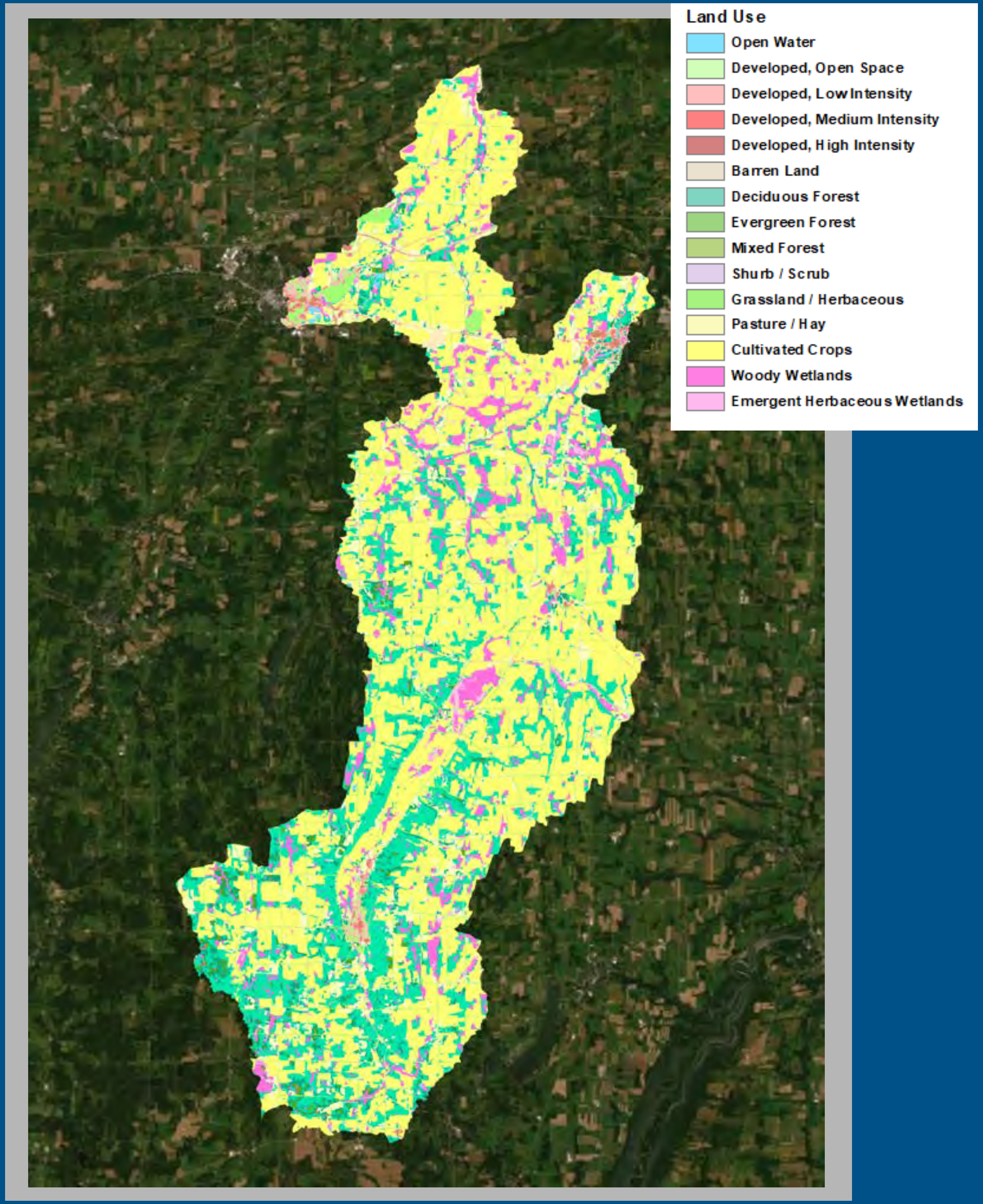
Hydrologic Soil Groups

- Soil types and hydrologic soil groups were determined from the USGS Soil Survey Geographic Database (2021).



Land Use

- Land use was determined from the National Land Cover Database (NLCD) from Multi-Resolution Land Cover Characteristics Consortium (2016).



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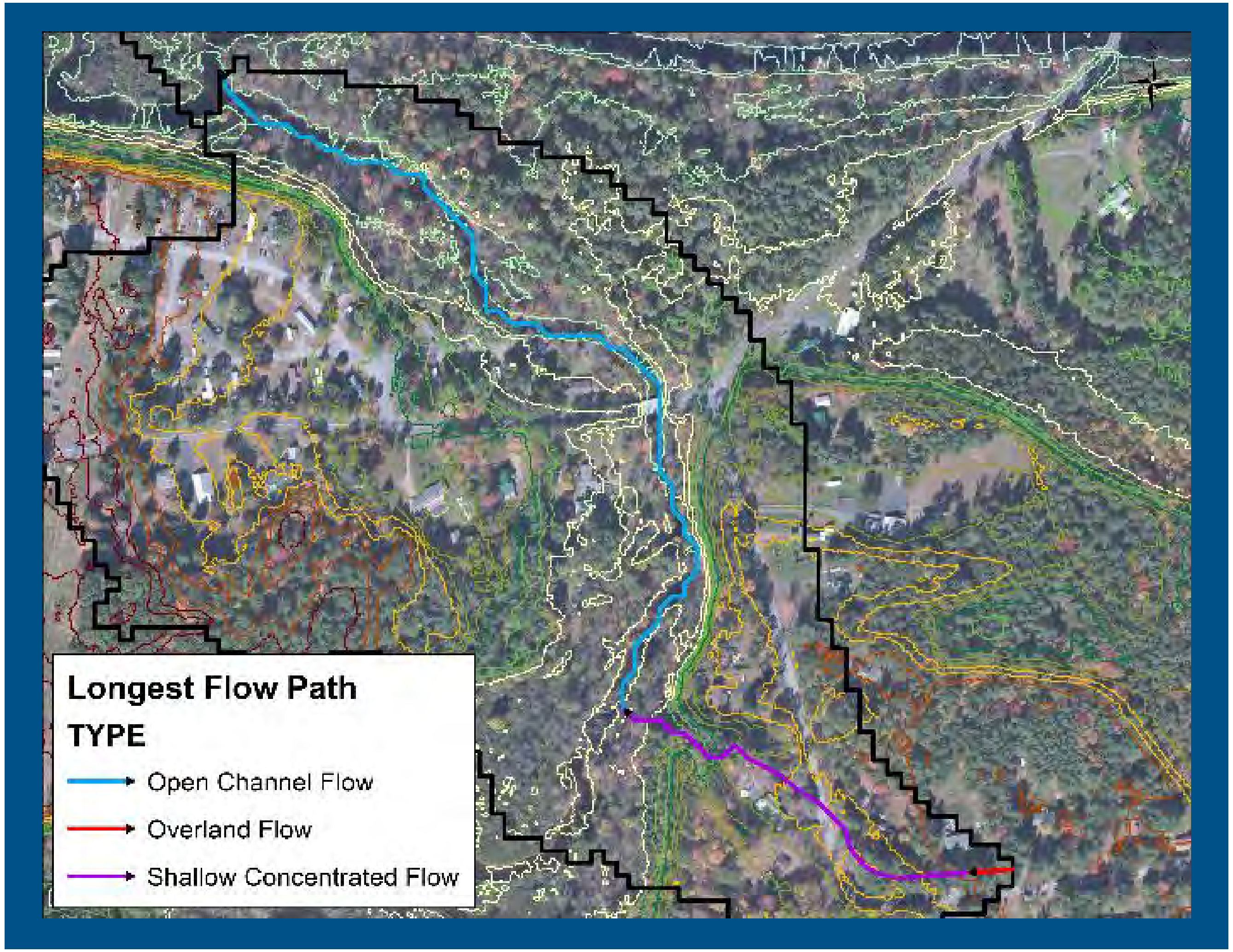
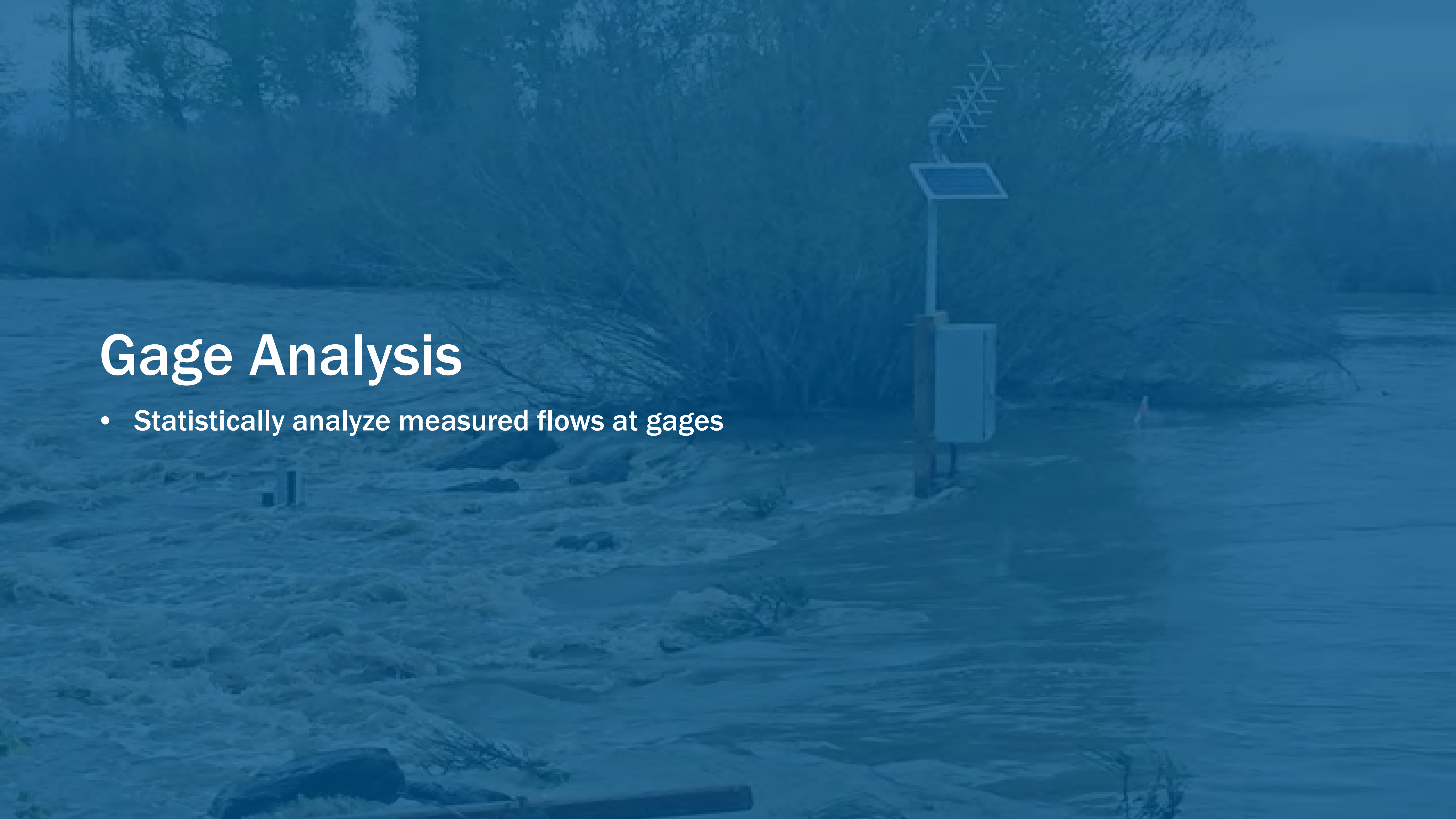
Rainfall-Runoff Modeling – Time of Concentration (Tc) / Lag Time

- Longest flow path = longest time that a drop of water would take to travel through a watershed
- 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 or 1,000 ft maximum
  - Channel flow: begins at end of shallow concentrated flow segment and ends at sub-basin outlet
- Lag times = 60% of Time of Concentration

Longest Flow Path Example





Gage Analysis

- Statistically analyze measured flows at gages

Hydrology – Gage Analysis

Gage Type	USGS Gage No.	Description	Drainage Area (sq. mi)	Period of Record	Number of Records
Discharge	4230380	Oatka Creek at Warsaw, NY	39.5	1964-2020	57
	4231000	Black Creek at Churchville, NY	130	1946-2020	75

- Flow gage analysis performed in support of rainfall-runoff model validation
- Viable gage = minimum 10 years current record
- Bulletin 17C methodology

Model Validation / Results

- Check computed flows against results from Effective FIS & LPIII values

Rainfall-Runoff Modeling – Model Validation

1. Compare drainage areas

- Drainage area of modeled location between 0.5 and 1.5 times that of gage

2. Estimate results that one would expect from gage using Drainage Area Ratio Method (USGS, 2008)

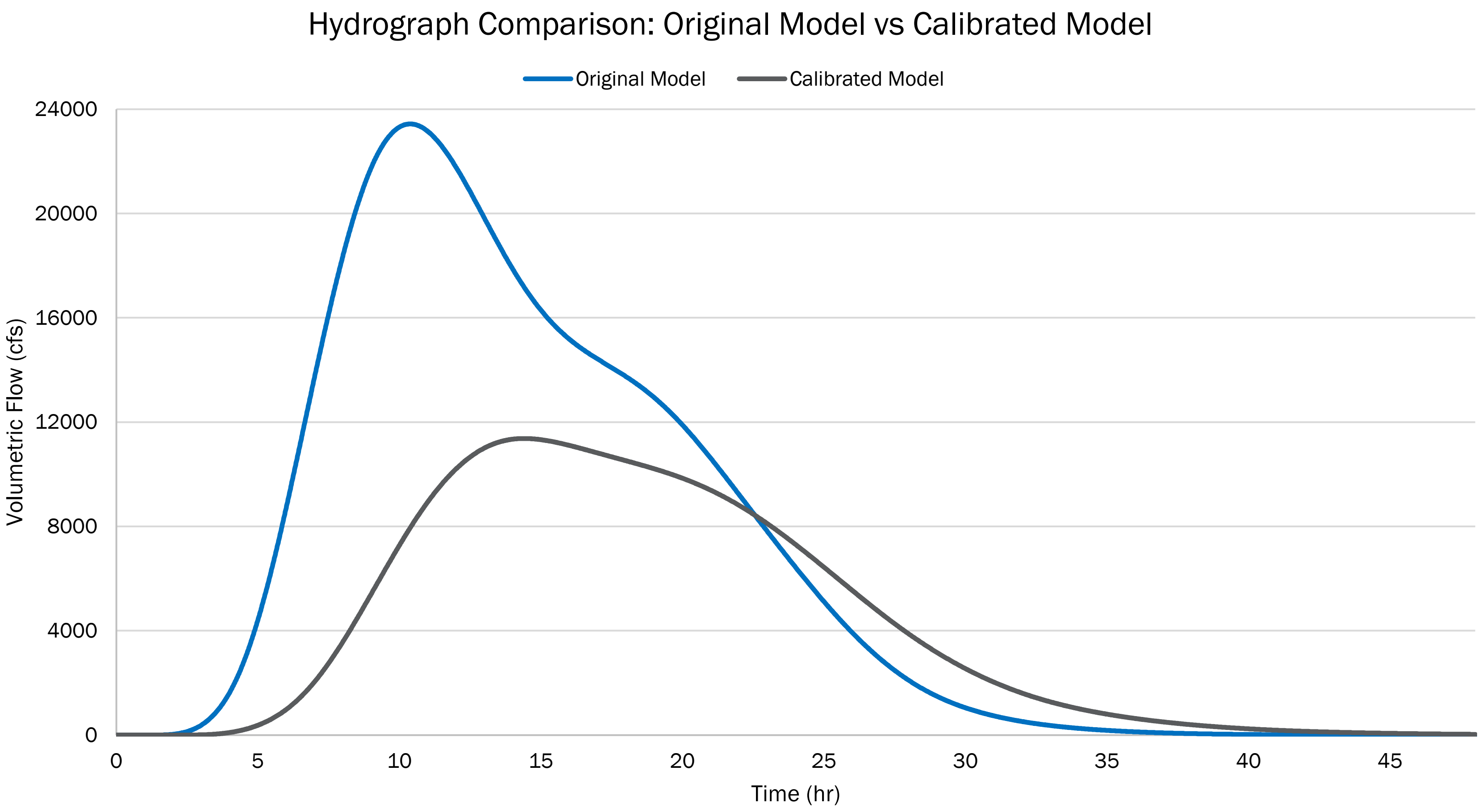
3. Adjust CN and lag time until model output is within 20% of expected gage output

- Adjustments within reasonable ranges of TR-55 tables – check imagery

4. At locations where no suitable gage comparison exists, make same average CN and lag time adjustments from nearby model locations

5. Peak flows for all computed 1%-AEP were reviewed and deemed to be valid

Rainfall-Runoff Modeling – Model Validation



Rainfall-Runoff Modeling - Comparison to Effective Flows

- New study found to be relatively consistent with effective flows
- On average, updated flows 17% lower than effective

Rainfall-Runoff Modeling – Model Validation

- Regression and Rainfall-Runoff: refer to Hydrology Report for results tables
- Stillwater elevations from volumetric analyses:

Computed Lake Stillwater Elevations (Feet NAVD88)

Site	10%-Annual Chance	4%-Annual Chance	2%-Annual Chance	1%-Annual Chance	0.2%-Annual Chance	1% Plus – Annual Chance	1% Minus – Annual Chance
Horseshoe Lake	778.7	778.7	778.9	780.2	782.5	780.5	780.0

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Genesee County Next Steps

Genesee County Next Steps

- Field reconnaissance
- Hydraulic analysis
  - Hydraulic modeling/report/submittal
  - Hydraulic analysis webinar
- Floodplain Mapping
- Flood Risk Review meeting
  - Comment period for communities

Project Timeline towards Preliminary Issuance

We are Here

Hydrology Presentation	Hydraulics Presentation	Floodplain Mapping	Flood Risk Review Meeting	Preliminary Map Products Issued
September 2021	Summer 2022	Winter 2022	Spring 2023	Summer 2023*

*Current timeline could be impacted by Flood Risk Review or Preliminary Map Comments

Graphic Above Not to Scale

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Thank you!

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