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Managing Water in the West

SEFM Case Study
Altus Dam, OK

Workshop on Probabilistic Flood Hazard Assessment
January 29 – 31, 2013

U.S. Department of the Interior
Bureau of Reclamation

Acknowledgements

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- Technical check and peer review provided by: Joseph Wright, Robert McGovern, Robert Swain, and John England

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Topics:

1. Project background
2. Calibration
3. Production runs
4. Results
5. Comparison to EMA

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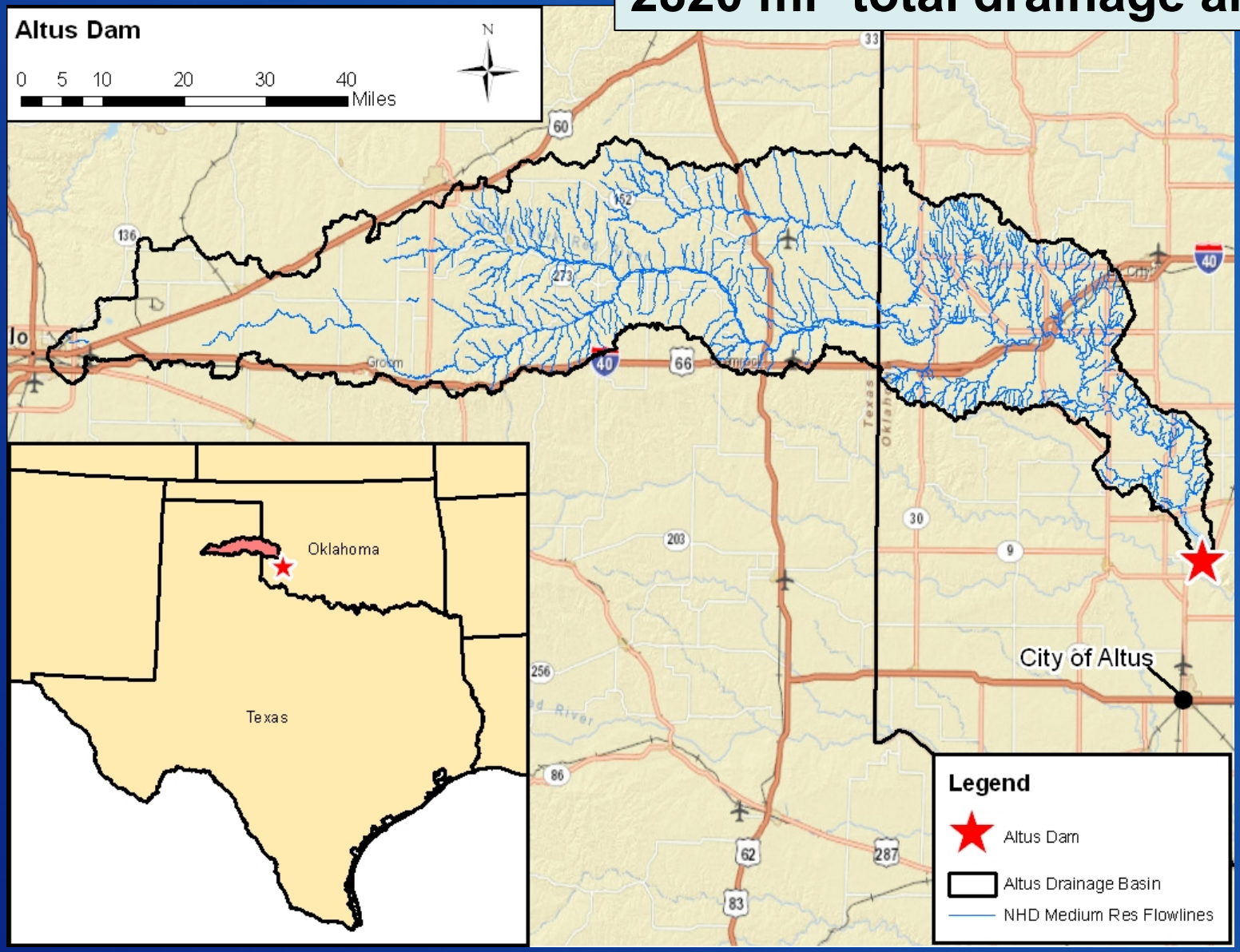
2820 mi² total drainage area



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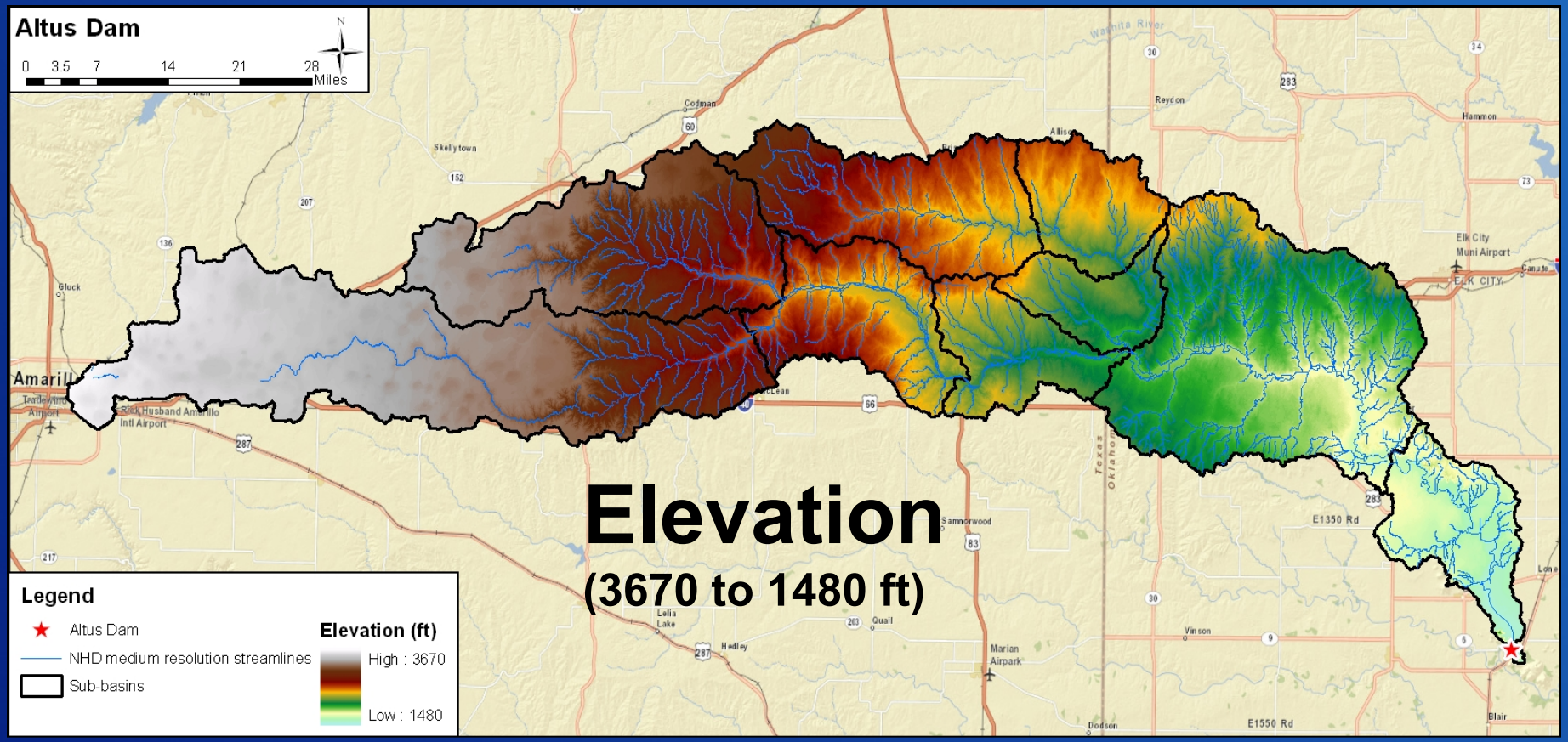
Drainage Basin Elevation



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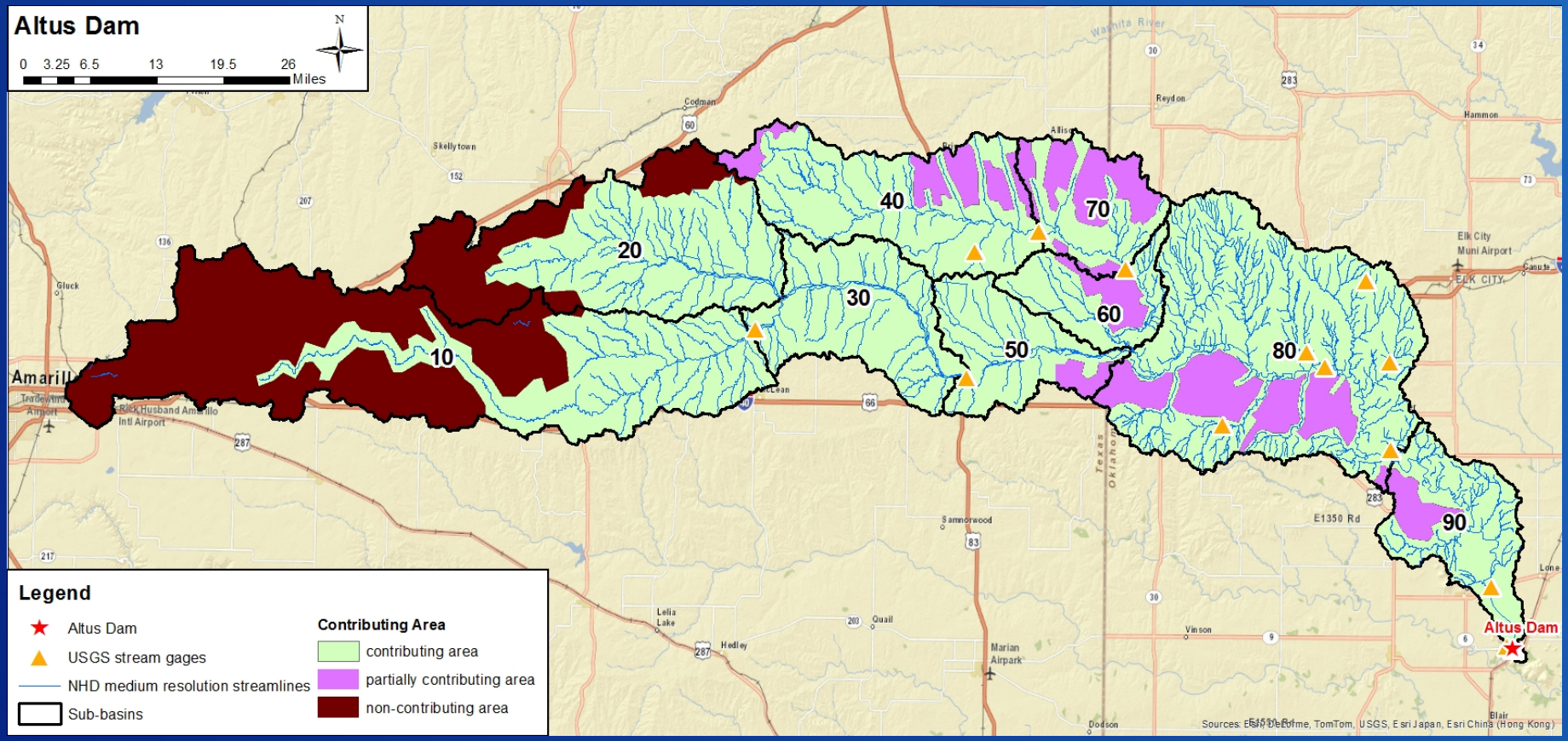
Non-contributing Area



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2. Calibration

GOAL – estimate fixed parameters to be used in production runs.

Calibration parameters:

1. **Soil infiltration parameters**
2. **Surface runoff parameters**
3. **Interflow parameters**
4. **Basin routing travel times**

PROCESS – Select model parameters that produce results that most closely match observed flows.

Inputs for Calibration Runs

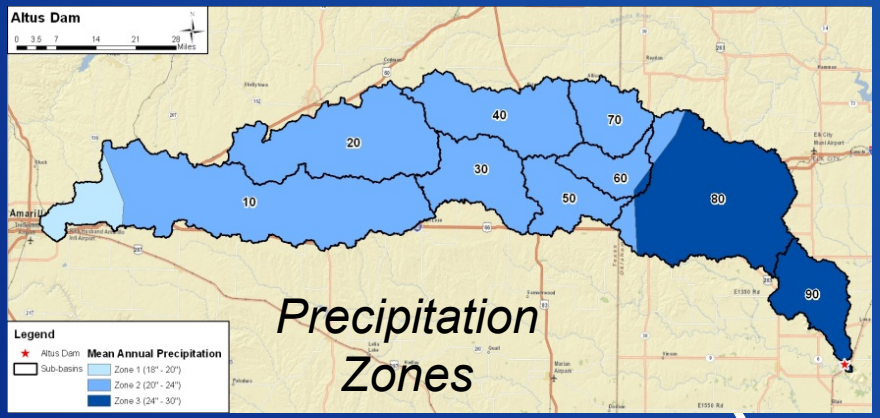
a) Hydrologic Runoff Units (HRUs)

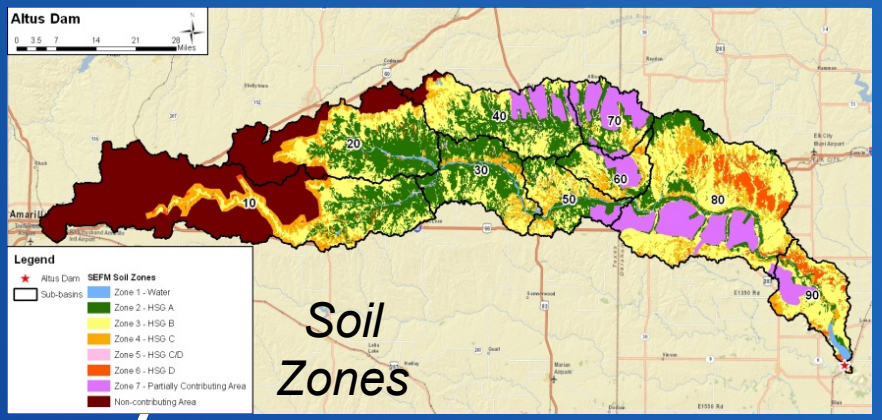
b) HEC-1 Template

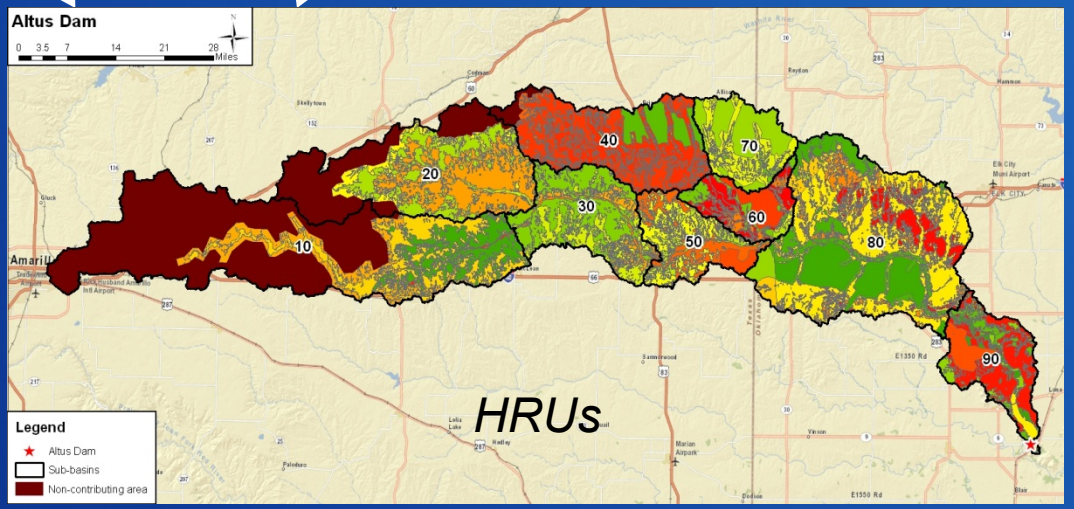
c) Meteorological Inputs

d) Hydrological Inputs

a) Hydrologic Runoff Units (HRUs)







Overlay:

- **Precipitation zones (3)**
- **Soil zones (7)**
- **Elevation zones (1)**
- **Sub-basins (9)**

→ 64 HRUs

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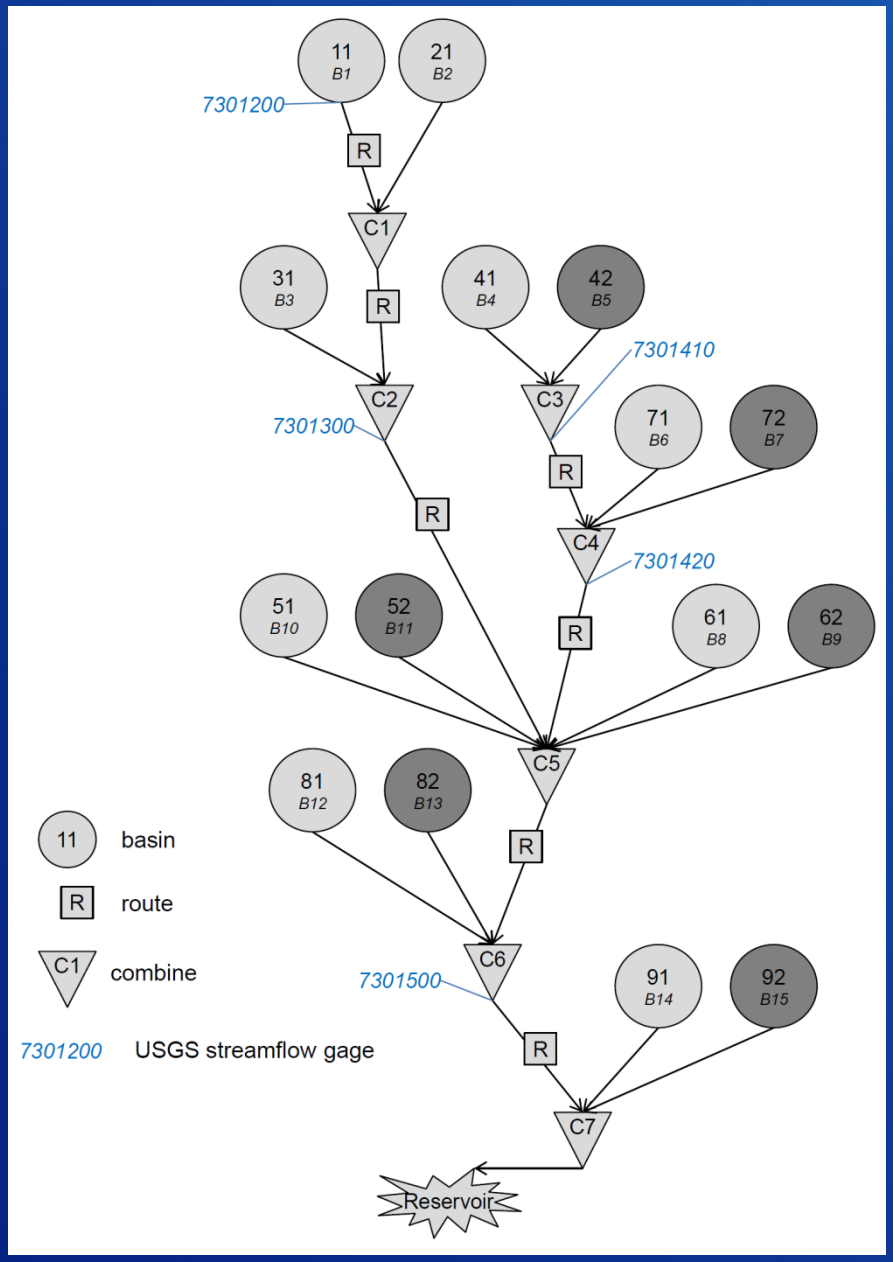

b) HEC-1 Template

SEFM calculates runoff from each sub-basin.

HEC-1 defines connectivity and routing between the basins.

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c) Meteorological Inputs

- Storm templates for each calibration storm
- Antecedent precipitation
- Evapotranspiration

d) Hydrologic Inputs

Streamflow observations for each calibration event

Provide range of parameters for calibration:

- **Soil infiltration parameters**
- **Surface runoff unit hydrograph parameters**
- **Interflow unit hydrograph parameters**

Soil Infiltration Parameters

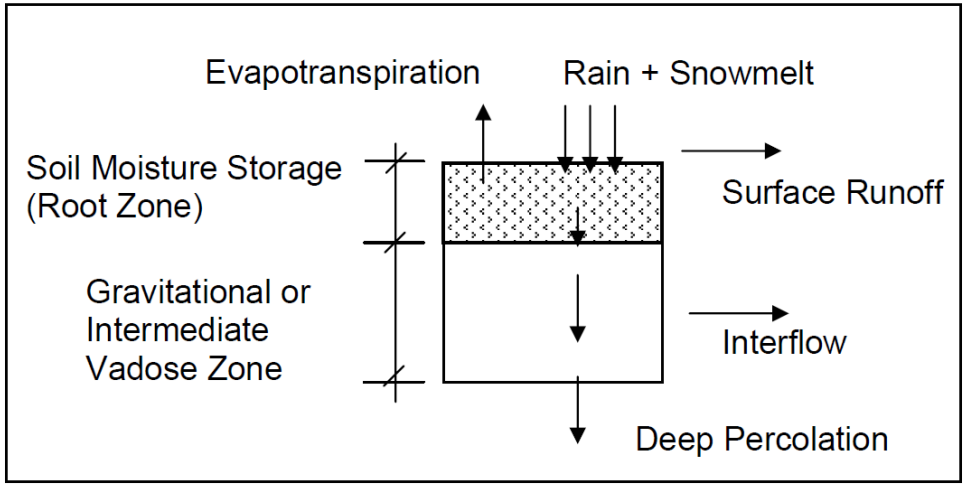

Figure 2-13.1 – Schematic of Soil Moisture and Runoff Processes Used in the Stochastic Model

$$F = (GIA)\ SMD^{IEXP} + FC \qquad (2\text{-}13.1)$$

$$GIA = (F_{max} - FC)/SMD_{max}^{IEXP} \qquad (2\text{-}13.2)$$

where:
- F – is the surface infiltration rate (inches/hour),
- GIA – is a soil zone specific constant that yields the maximum surface infiltration rate when the soil moisture content is equal to the wilting point,
- SMD – is the soil moisture deficit (inches),
- SMD_{max} – is the maximum soil moisture deficit, which equals the soil moisture storage capacity (inches)
- $IEXP$ – is the infiltration exponent, default value is 1.4,
- FC – is the minimum surface infiltration rate for the soil zone (inches/hour),
- F_{max} – is the maximum surface infiltration rate for the soil zone (inches/hour).

(Schaefer and Barker, 2004)

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Surface runoff unit hydrograph

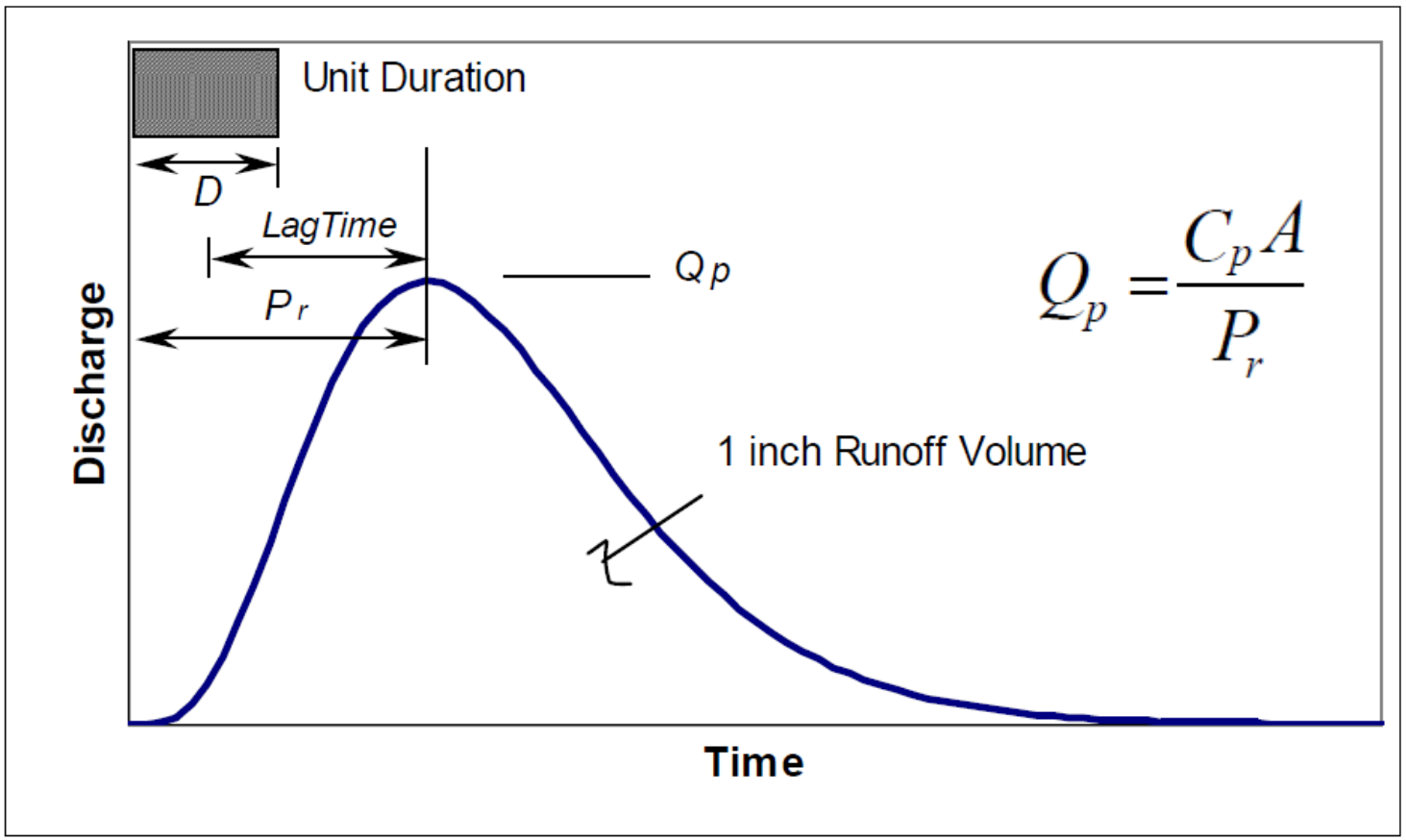

Figure 2-14.1 – Characteristics of Unit Hydrographs

(Schaefer and Barker, 2004)

Interflow Parameters

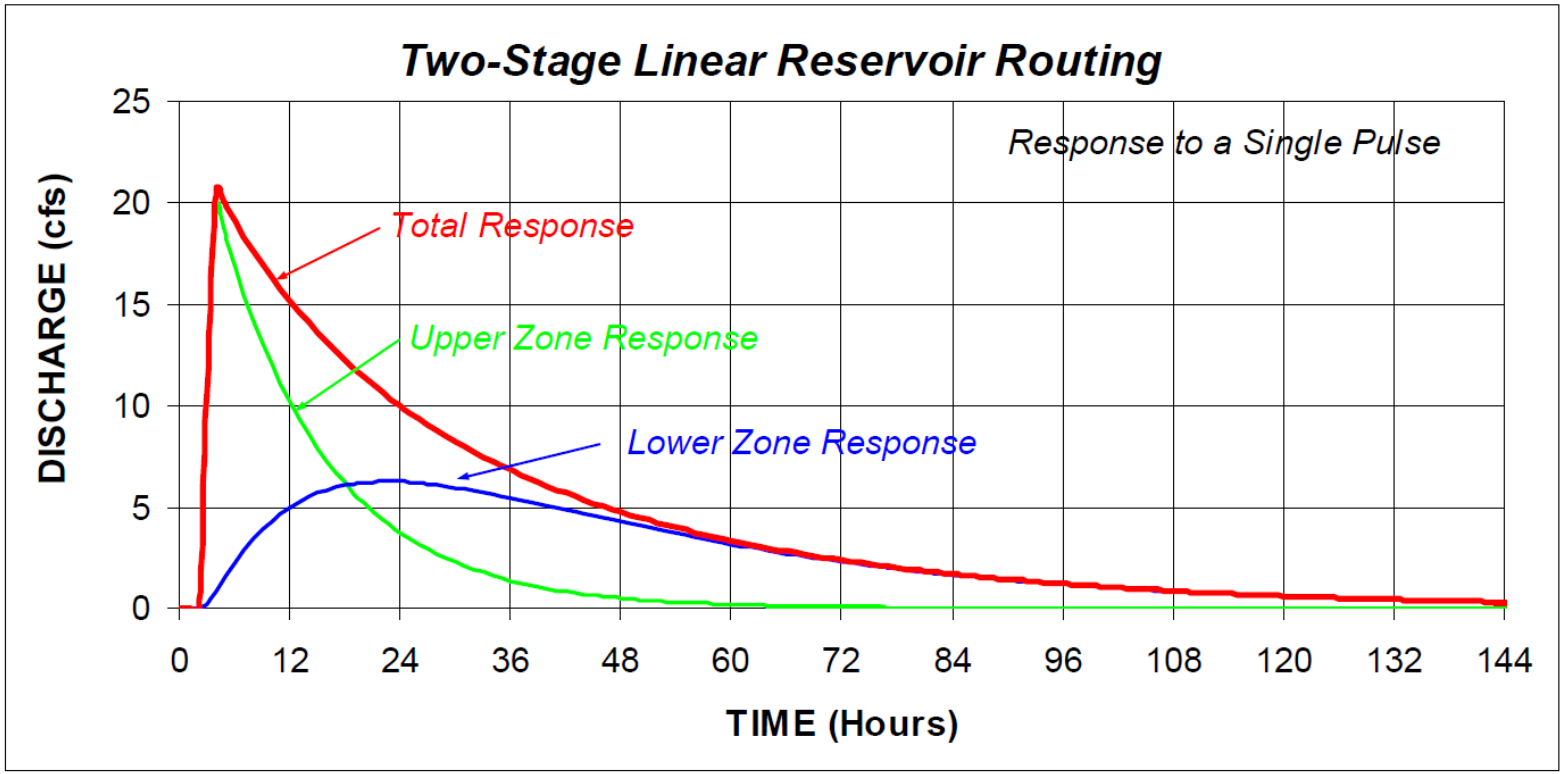

Figure 2-15.1 – Example of Two-Stage Linear Reservoir Routing for Interflow Runoff

(Schaefer and Barker, 2004)

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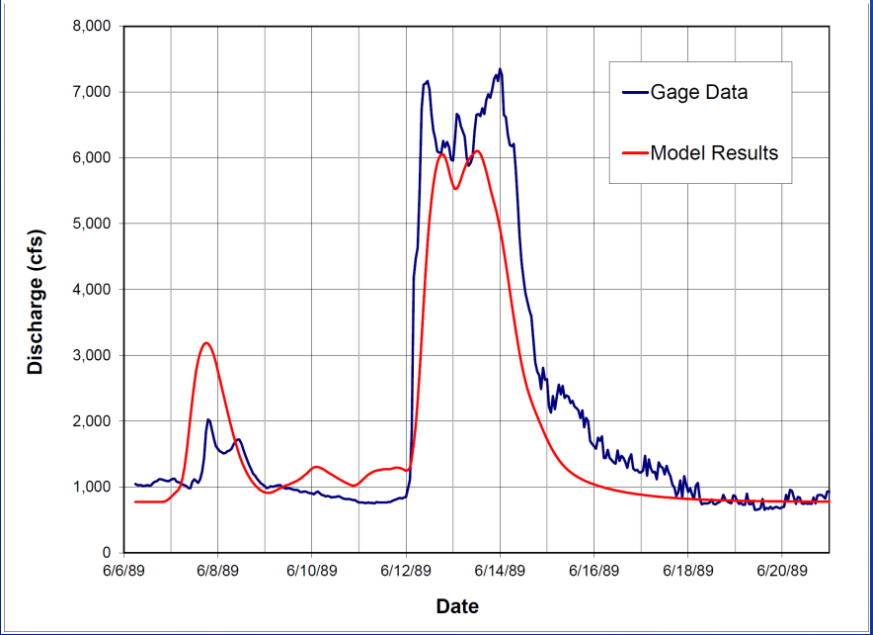
Calibration Process

Generalized Likelihood Uncertainty Estimation (GLUE) method (Beven and Binley, 1992)

Compare model results to observed flows to determine best input parameters for the model:



- **Calculate goodness-of-fit measures**
- **Calculate % error for Qp and V**
- **Visually compare hydrograph shapes**

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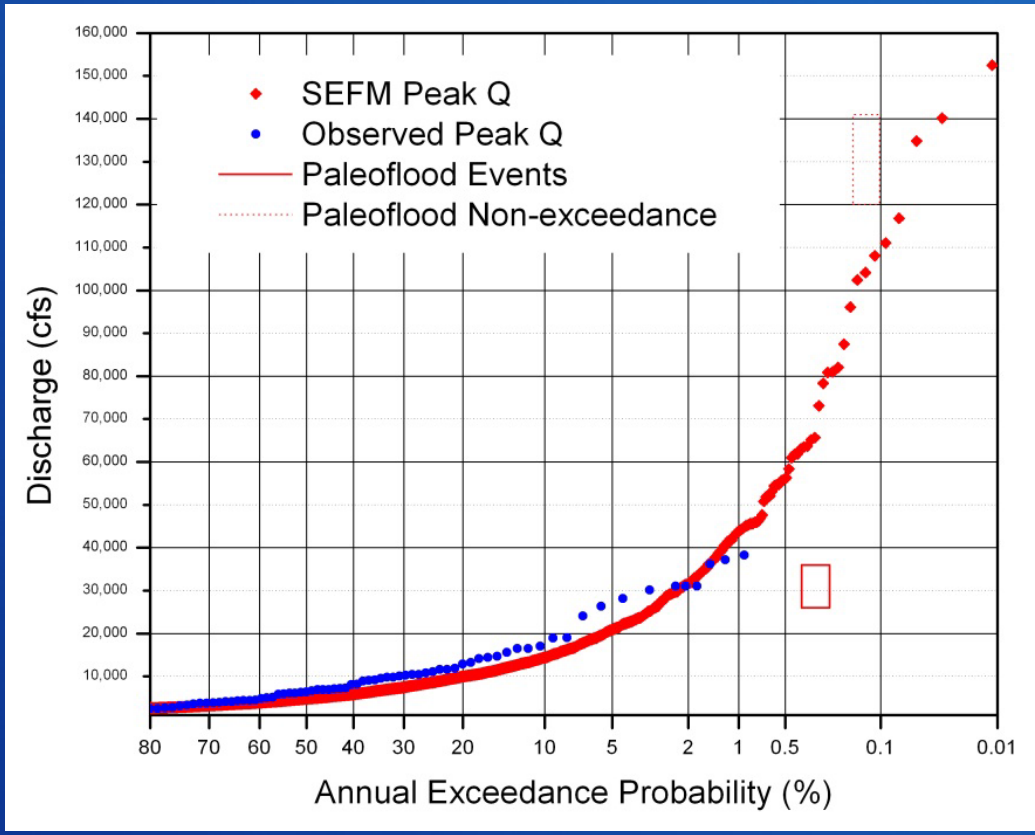
Calibration Process

Perform a frequency run and compare frequency curves from model to frequency curves from streamflow data.

- **peak flows**
- **24-hr mean flows**
- **72-hr mean flows**



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Topics:

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3. Inputs for Production Runs

a) Hydrologic Runoff Units (HRUs) – same as calibration

b) HEC-1 Template – same as calibration

c) Meteorological Inputs

d) Hydrological Inputs

c) Meteorological Inputs

- Storm duration
- Storm volume (precipitation magnitude frequency)
- Storm templates (spatial and temporal distribution)
- Storm seasonality
- Antecedent precipitation
- Evapotranspiration

d) Hydrologic Inputs

- Antecedent soil moisture
- Soil moisture at start of climatic year
- Antecedent streamflow
- Initial reservoir elevation

- Calibrated values:
  - Soil infiltration parameters
  - Surface runoff unit hydrograph parameters
  - Interflow unit hydrograph parameters

Production Runs

- Specify the number of runs
- Specify the plotting position
- Run SEFM:
  - SEFM selects a month of storm occurrence
  - A storm template is selected and scaled
  - Parameters are selected based upon month
  - HEC-1 input files generated for each simulation

Production Runs

- Run HEC-1 batch file
- Import HEC-1 output files into SEFM
- Events are ranked to develop frequency curves

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Topics:

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4. **Results**
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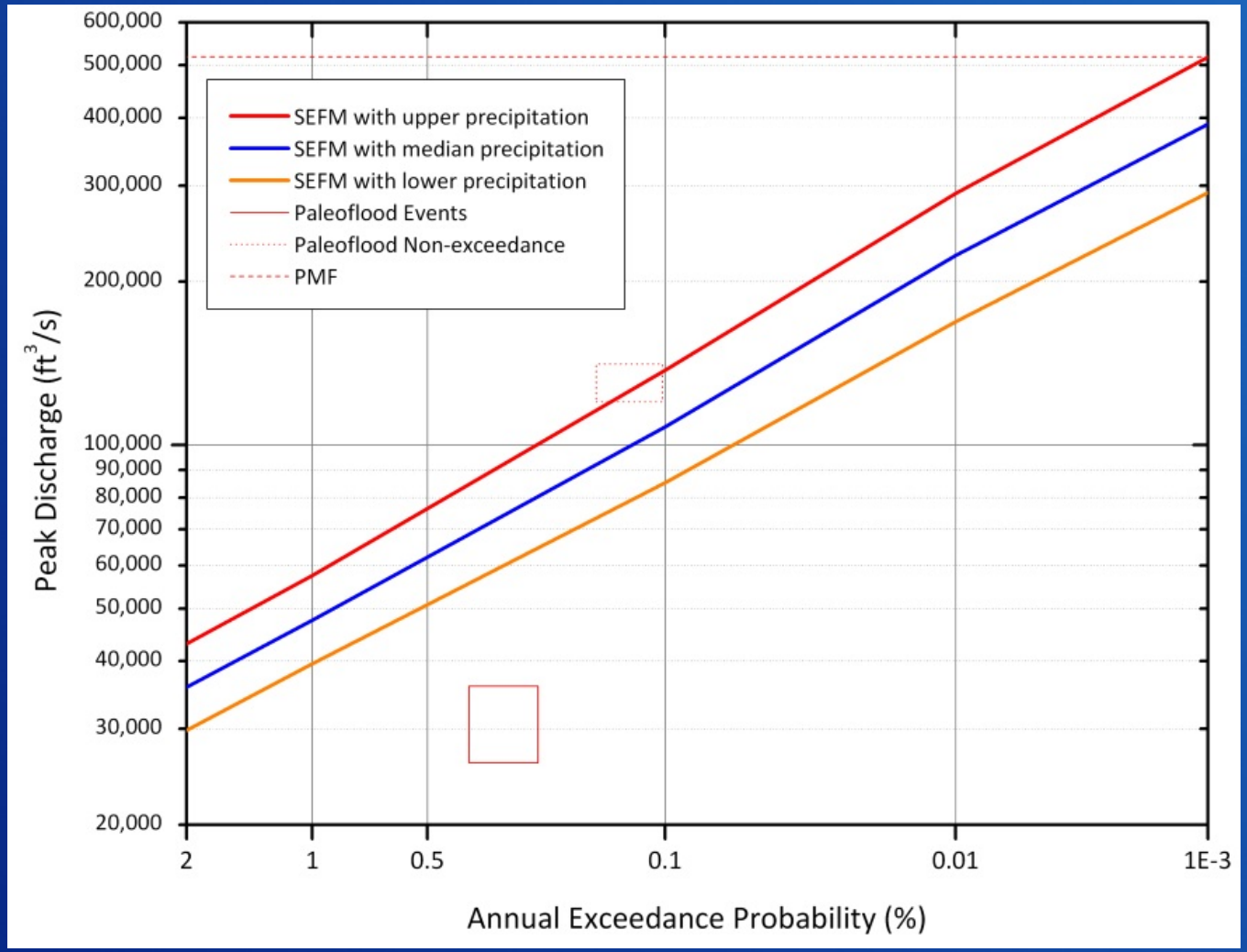
Peak Discharge frequency curves



Red – 95th percentile precipitation
Blue – 50th percentile precipitation
Orange – 5th percentile precipitation

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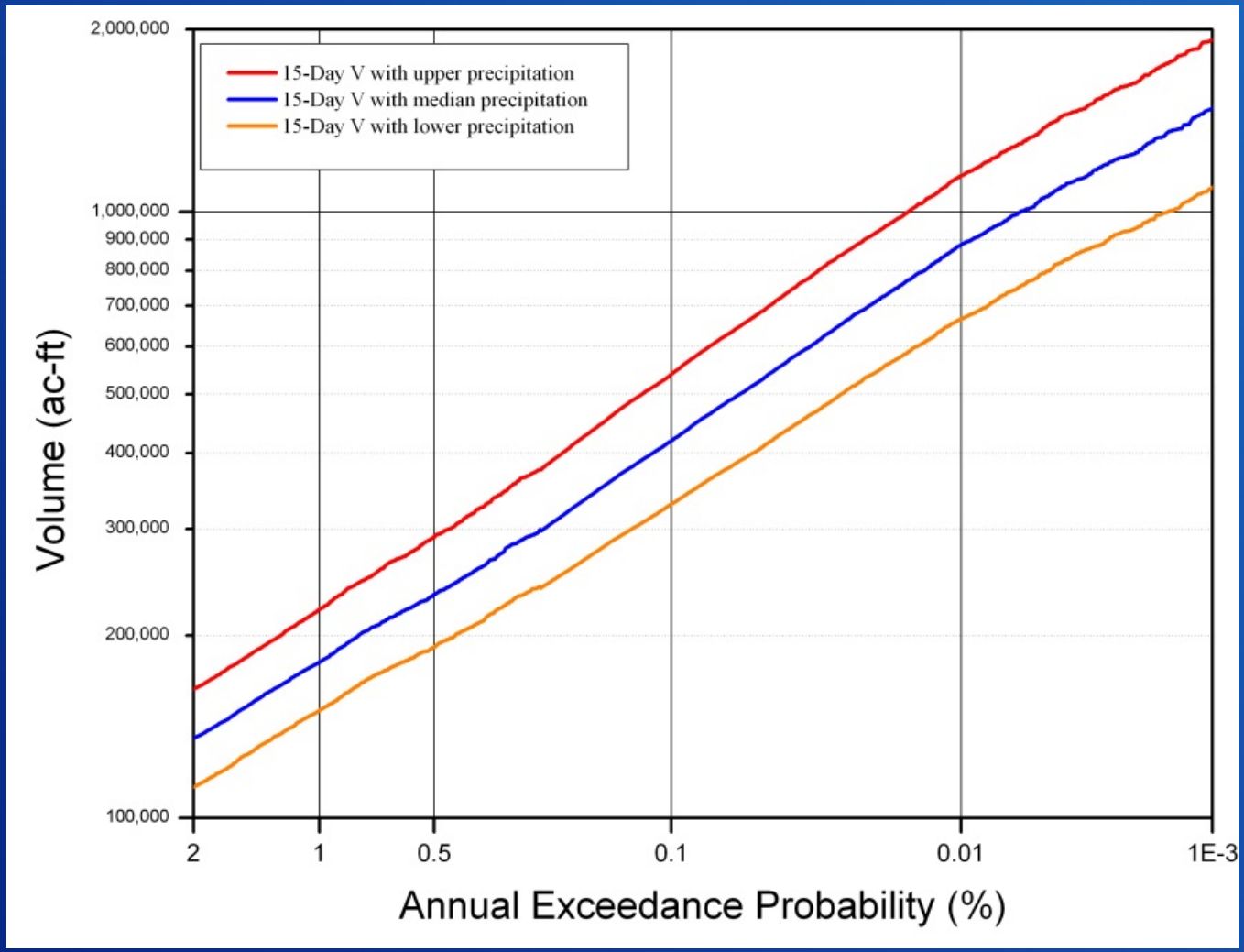
15-day volume frequency curves



Red – 95th percentile precipitation
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Orange – 5th percentile precipitation

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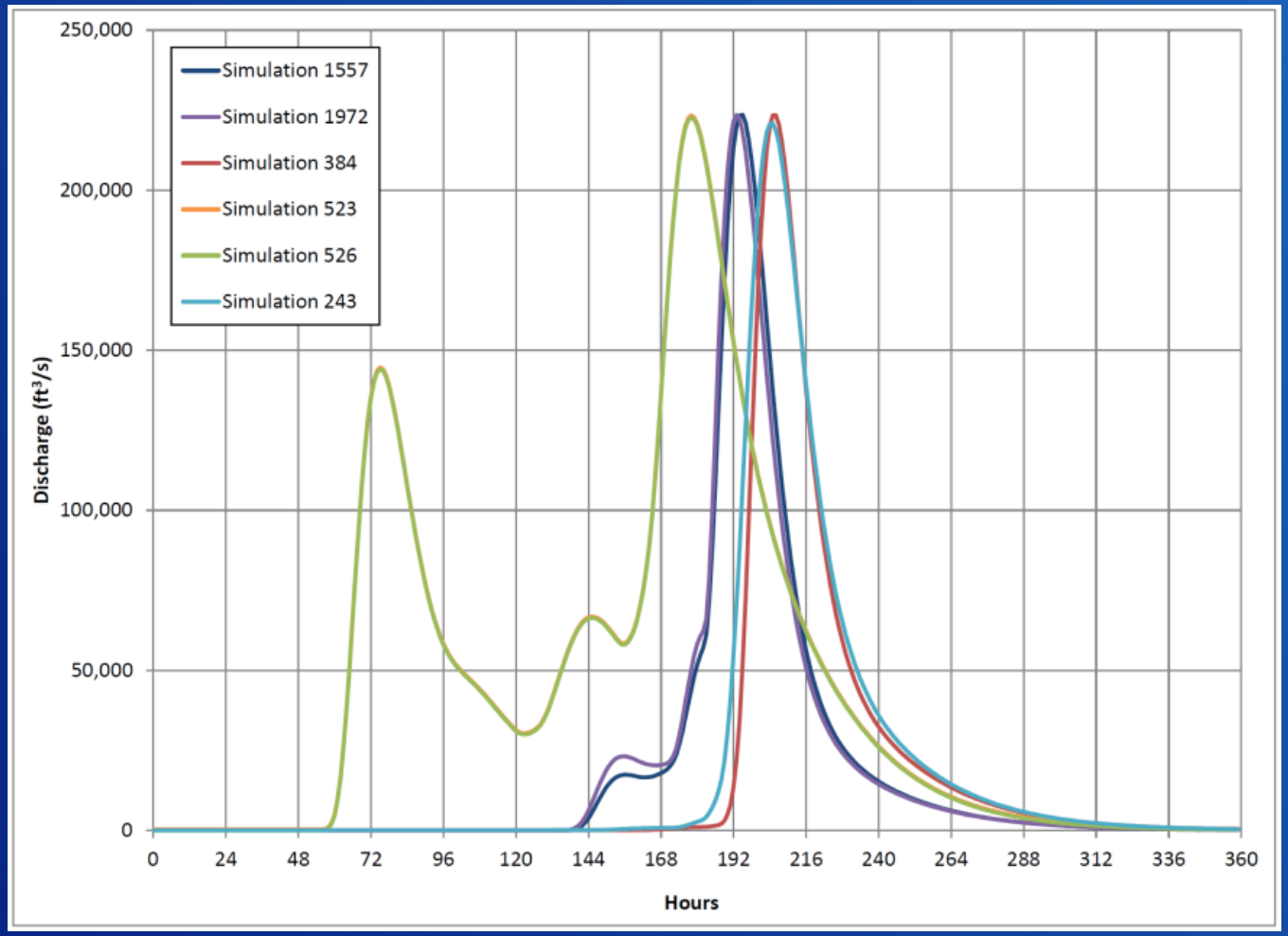
10,000-yr Hydrographs based on Peak Discharge



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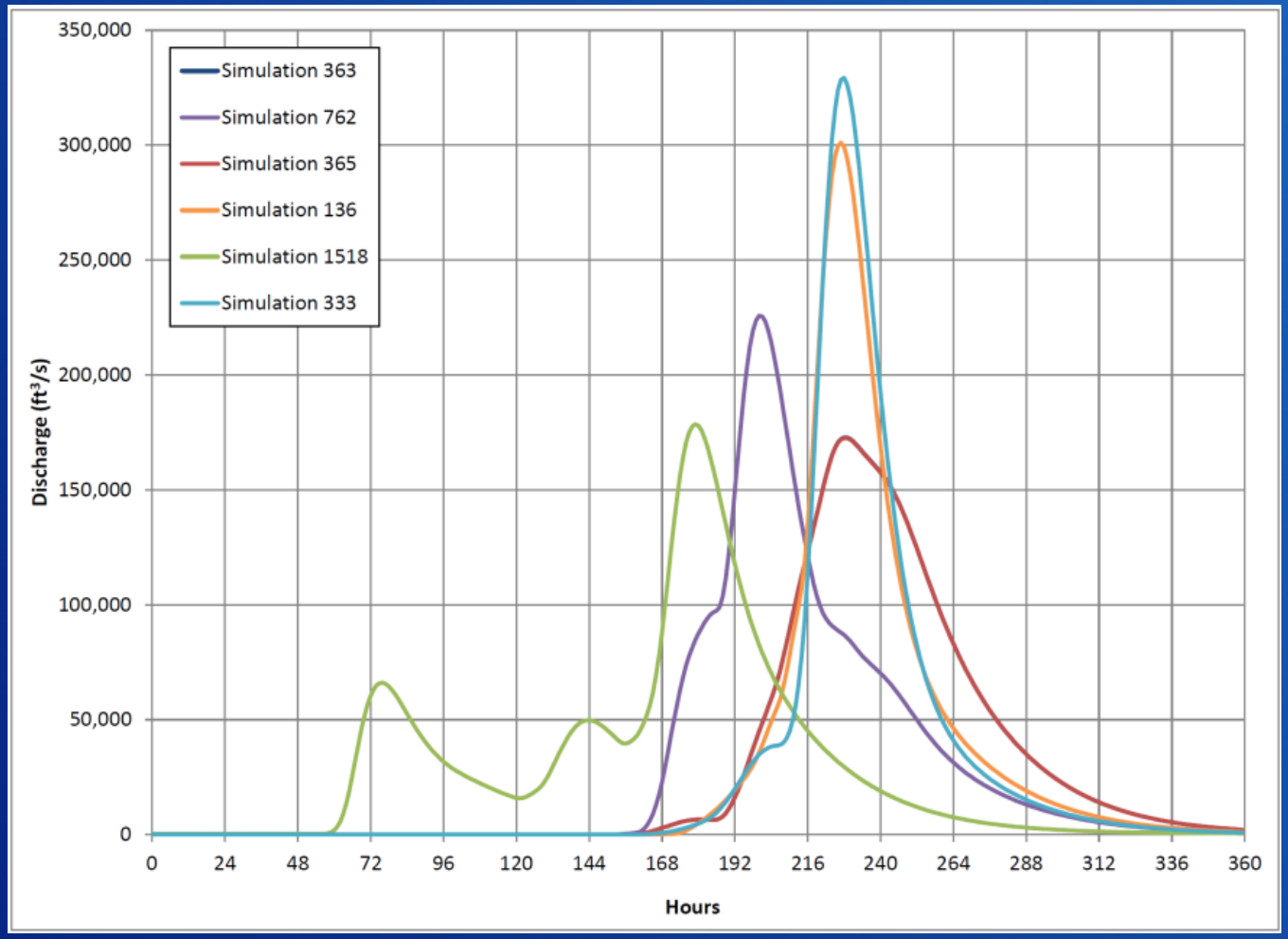
10,000-yr Hydrographs based on Volume



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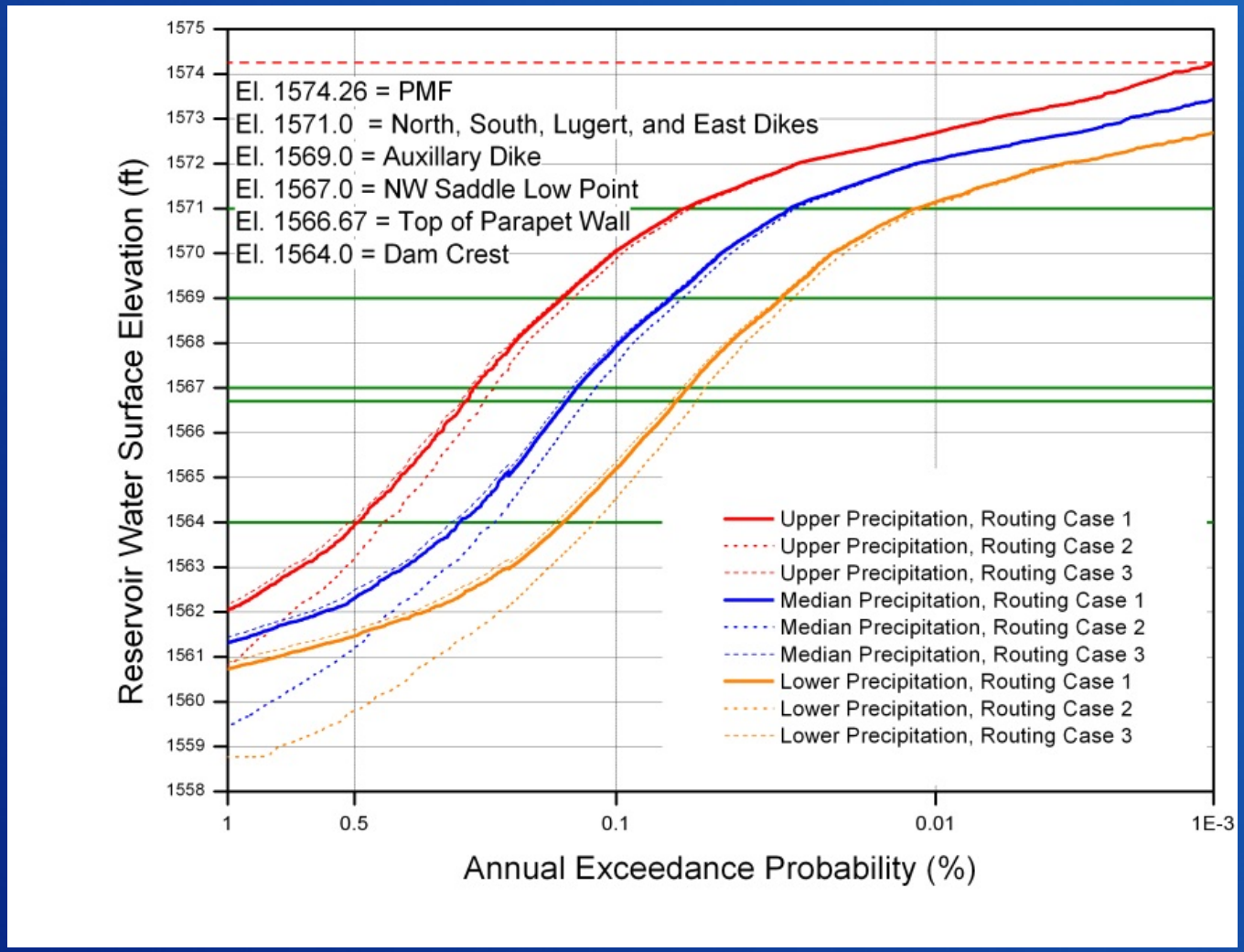
Reservoir elevation frequency curves



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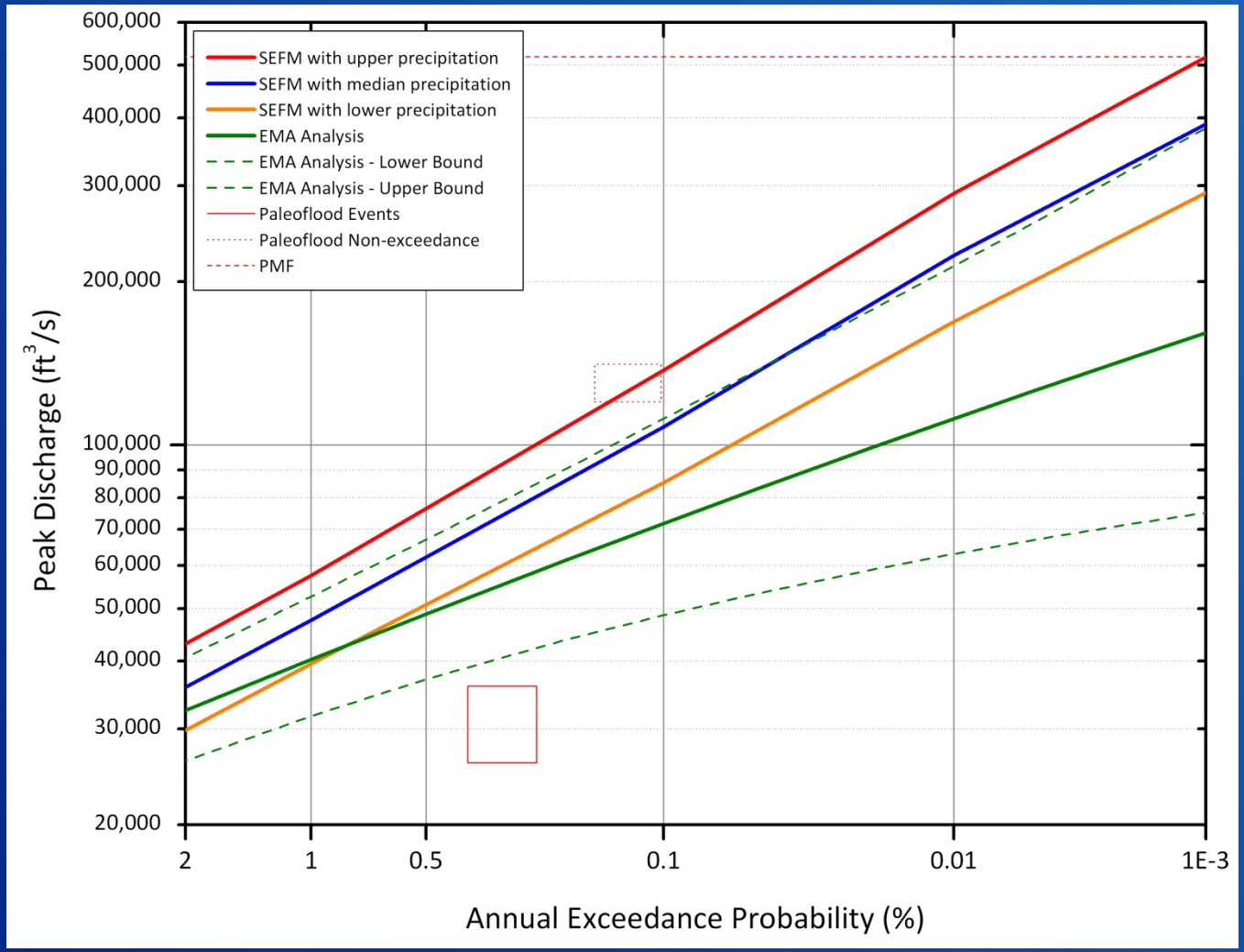
Comparison to EMA with paleoflood data



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Thank You

Questions?

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