



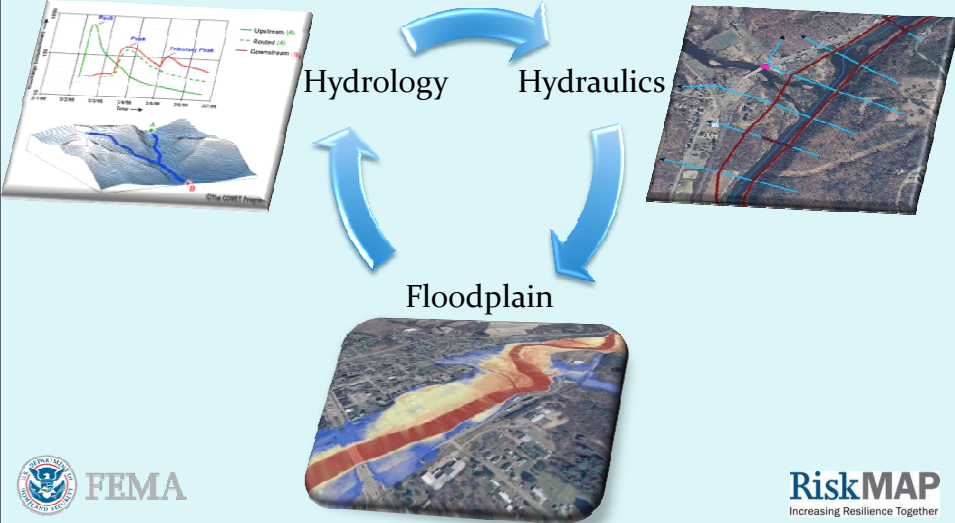
# FEMA Riverine Flood Study

## Basics of Floodplain Analysis

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# Introduction



Hydrology      Hydraulics

Floodplain



## Basic Steps

### HYDROLOGY

- Estimating the volumetric flow in river
- Assigning a probability to the flow
- Probability –statistical Analysis
- Stream gage or rain gage data

### HYDRAULICS

- Topography of channel and floodplain
- Apply discharges estimated in hydrology
- Compute flood elevations
- Floodplain
- Floodway



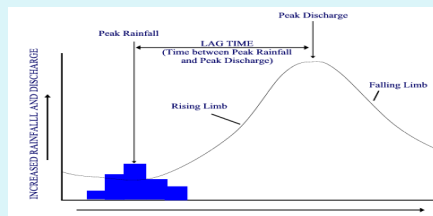
## Discharge Computation

Statistical/Empirical relationships

Peak flows

Watershed Models

Peak Flows as Hydrograph



## Flow Measurement

- Stream Gages
  - USGS measures stream flow (observing stage above specified datum and then relating stage to discharge via rating curve)
  - Peak stream flow is measured at 27,916 sites
  - Used to develop frequency-based annual peak discharge
- Statistical Analysis
  - Historic stream flow can be used
  - Assign a probability to annual peak flows
  - Estimate peak flow with a known frequency return period



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## Flood Frequency Analysis

- Statistical curve fitting
- Log Pearson Type III analysis is used in USA
- Plotting positions computed based on annual peak flow record available at stream gage stations
- Bulletin 17B defines the procedures
- Software available for calculations – Peak FQ, HECResSim
- More number of observed records, more accurate are the estimates



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## USGS Regression Equations

- For ungaged watersheds
- Based on frequency discharges are computed at stream gage locations
  - Mostly for rural watersheds, urban correction available
  - Must be unregulated – no large reservoirs or dams
- Based on watershed parameters
  - Drainage area, stream slope, impervious cover, storage, etc.
  - USGS reports:  
<http://water.usgs.gov/osw/programs/nss/pubs.html>

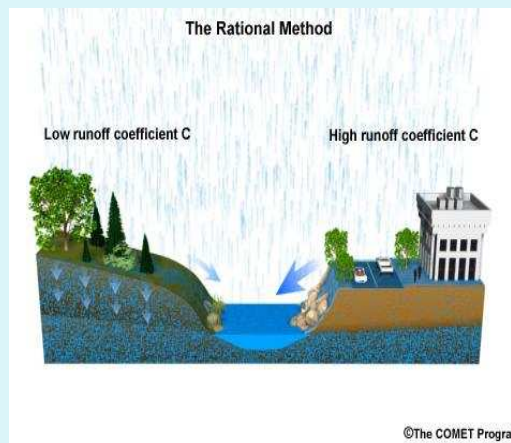


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## Rational Method

- Simple method that takes into account land use characteristics for small basins using a land-use runoff coefficient, or “C” value.
  - “C” values vary from near zero in rural or forested areas to almost 1.0 in urban areas and parking lots



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## Watershed Model Development

- Rainfall – runoff modeling to develop discharge hydrograph
- Topography (Stream network, watershed boundary)
- Basin Characteristics
  - Type of Land Cover
  - Soil type
- Calibration is recommended
- Frequency Discharges
  - Rainfall from NOAA
  - NWS NexRAD



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## FEMA Base Flood

- Discharge with 1% annual chance exceedance (aka 100-year flood discharge)
  - Used for Base Flood Elevation (BFE) computation
- Also known as Base Flood Discharge
- Other Frequency Discharges Computed
  - 10%, 2%, 0.2% (10-year, 50-year, 500-year)



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## Hydraulics Analysis Methods

- Purpose:
  - Develop regulatory products
    - Base Flood Elevation
    - 1% and 0.2% floodplains
    - 10%, 2%, 1%, and 0.2% annual chance profiles
  - Develop non-regulatory products
    - Depth grids
    - Velocity grids
- Methods:
  - Steady State: Flow is constant with time (1D or 2D)
  - Unsteady State: Flow varies with time (1D or 2D)

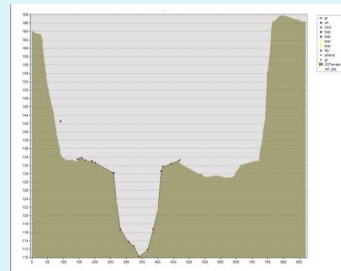


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## HEC-RAS (1D, Steady Flow) Input

- Cross-sections
  - Perpendicular to floodplain
  - Spacing based on the geometry and roughness
  - At abrupt change in shape, area, slope and roughness
  - Channel geometry is based on survey and overbank geometry is based on LiDAR data





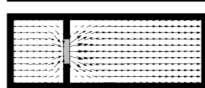
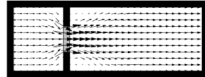

## HEC-RAS (1D, Steady Flow) Input

- Hydraulic Structures
  - Flow at structure
    - Free surface flow
    - Pressure flow
    - Weir flow
  - Structure geometry
    - Field survey
    - As-built
  - Assumed to be free of obstruction/blockage



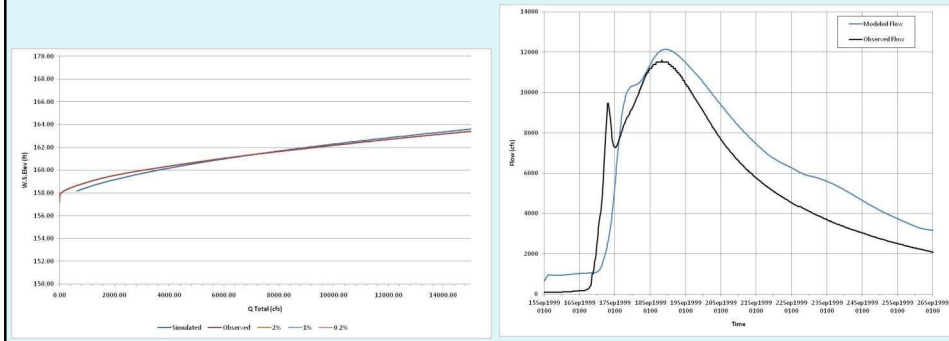
## HEC-RAS (1D, Steady Flow) Input

- Loss coefficients
  - Friction losses are represented by manning's n-values
    - Size and makeup of river bed/overbank
    - Slope of channel
    - Type and density of vegetation
    - River meandering
    - Depth of flooding
  - Eddy Losses are computed as fraction of difference in velocity head
    - Contraction coefficient
    - Expansion coefficient



## Calibration and Verification

- High water marks (HWM's)
- USGS gage rating curves
- Stage and flow hydrographs



## Floodway

- Must be kept free of encroachment to convey the 100-year flood
- Increase in flood elevation (surcharge) is kept to less than a maximum, generally 1.0 foot



