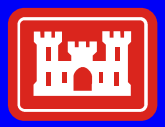
Advances to the GSSHA model

Aaron Byrd
Cary Talbot
ERDC-CHL

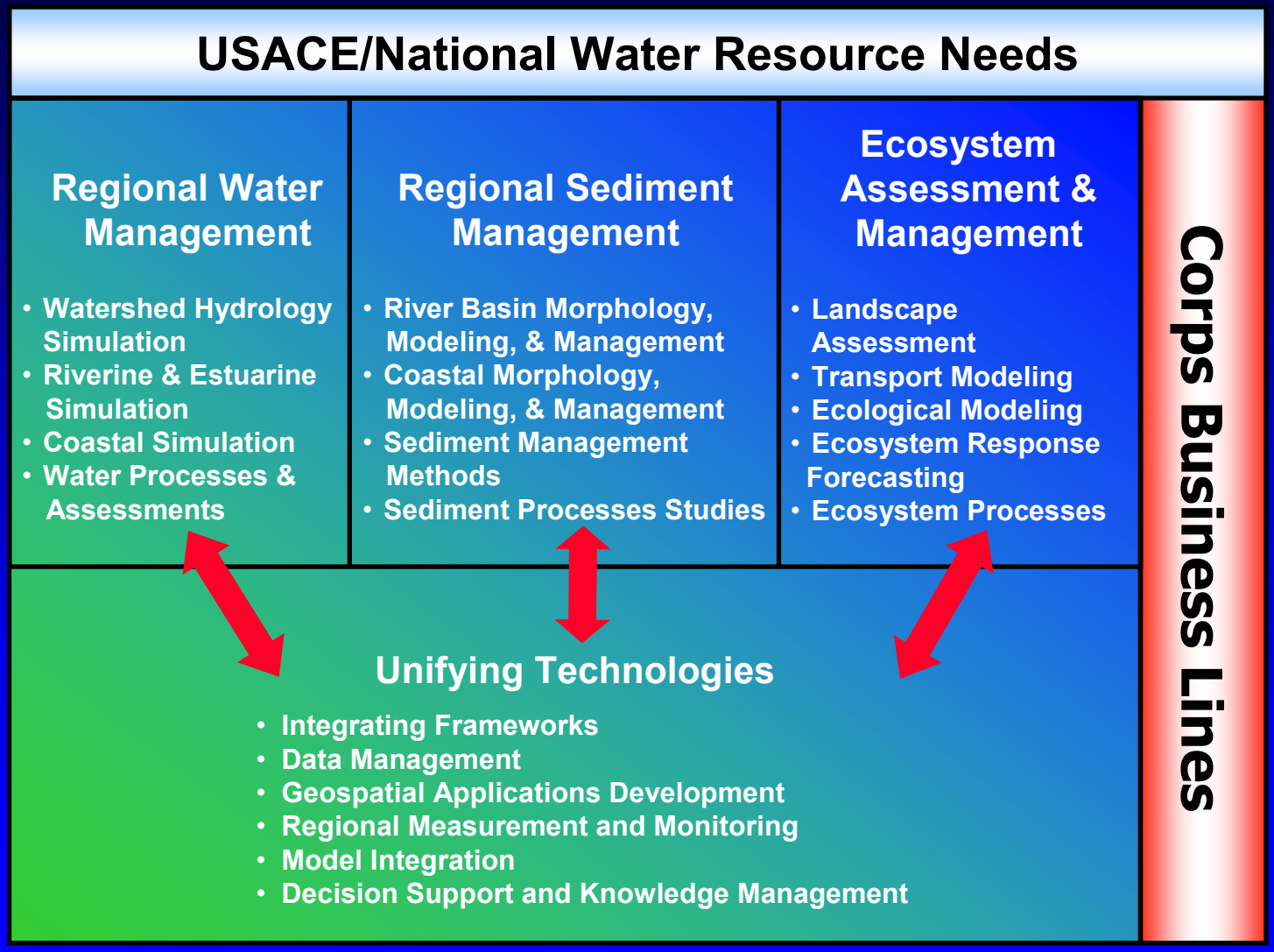


System-Wide Water Resources Program (SWWRP)

- 7-year USACE R&D initiative designed to assemble and integrate the diverse components of water resources management
- The ultimate goal is to provide to the Corps, its partners, and stakeholders the overall technological framework and analytical tools to restore and manage water resources and balance human development activities with natural system requirements

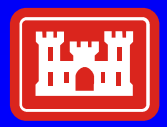
https://swwrp.usace.army.mil

SWWRP Program Structure



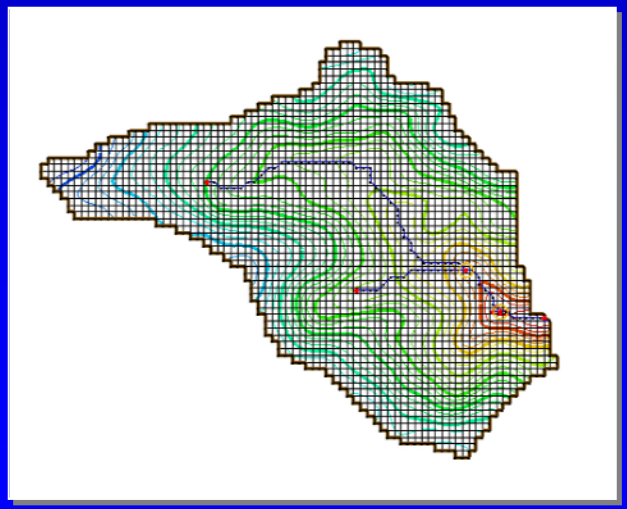
SWWRP
Watershed Hydrology Simulation

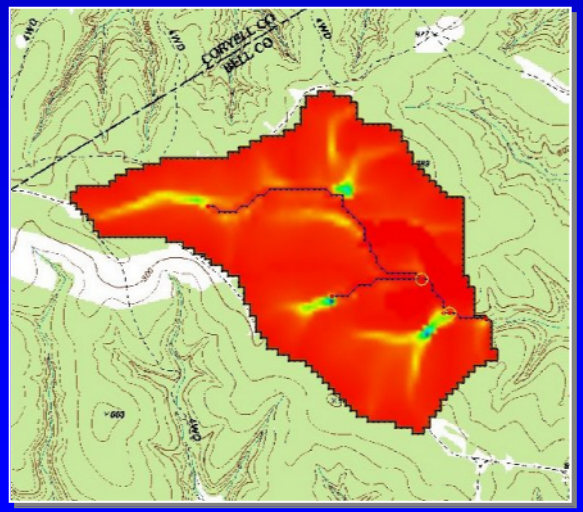
- 5 Research Areas
  - HMS development
  - GSSHA development
  - Uncertainty/parameter estimation/stochastic simulation tools for system-scale models
  - Regional flood prediction
  - Coupled, multi-dimensional groundwater-surface water interaction simulation



GSSHA

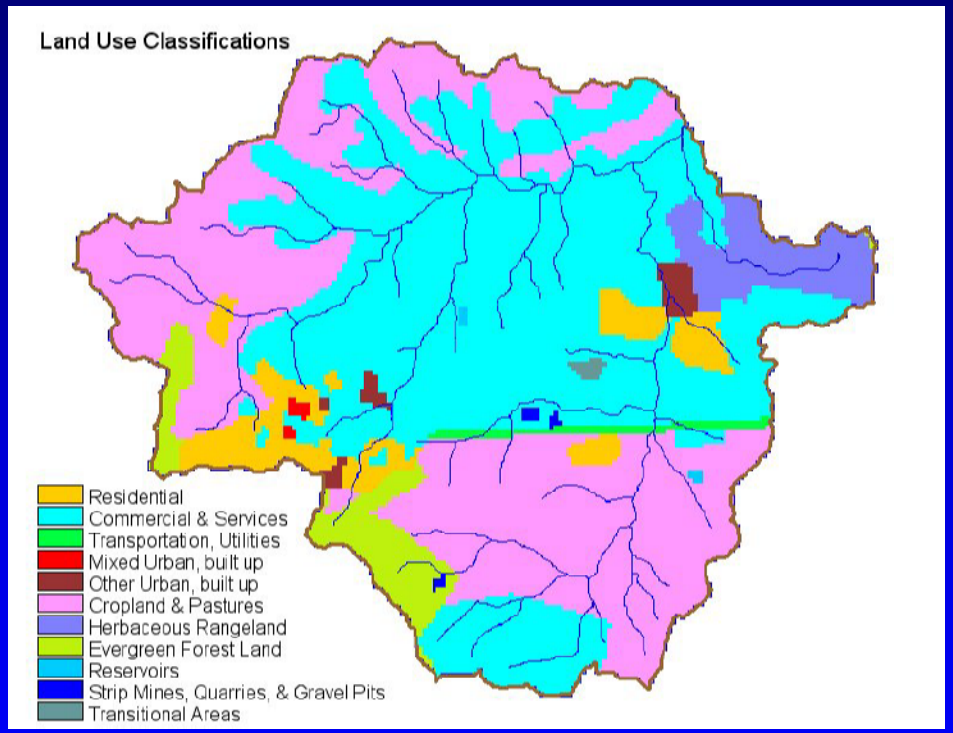
- Distributed, physically-based Gridded Surface Subsurface Hydrological Analysis (GSSHA) model
- Simulates 2D overland flow, 1D channel routing, 2D saturated groundwater flow, canopy retention, microtopography, 1D infiltration and ET using finite-difference and finite-volume methods

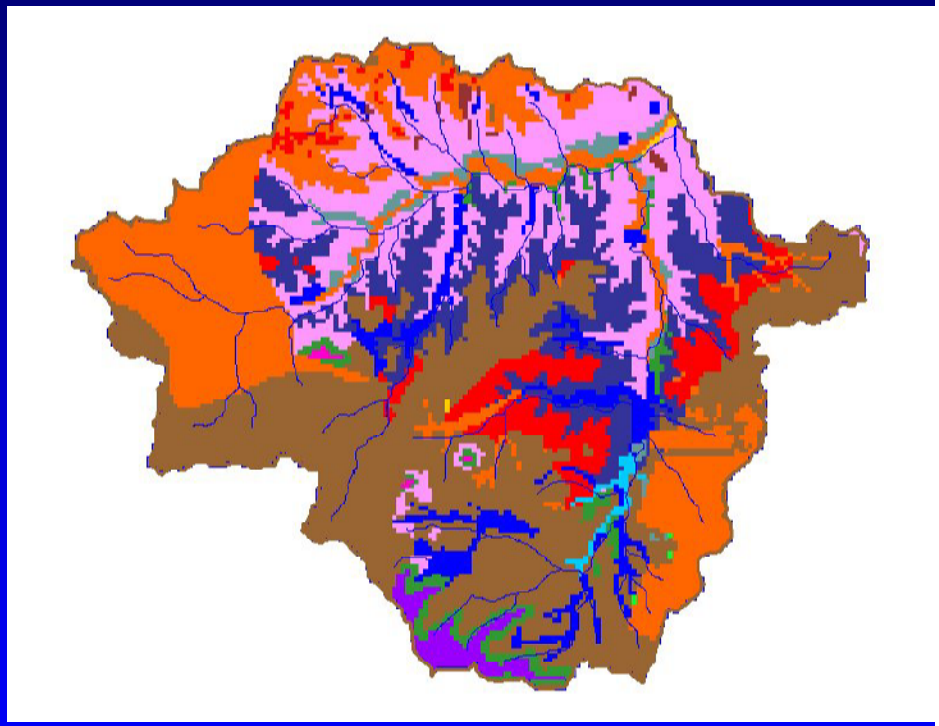




Distributed Hydrologic Parameters

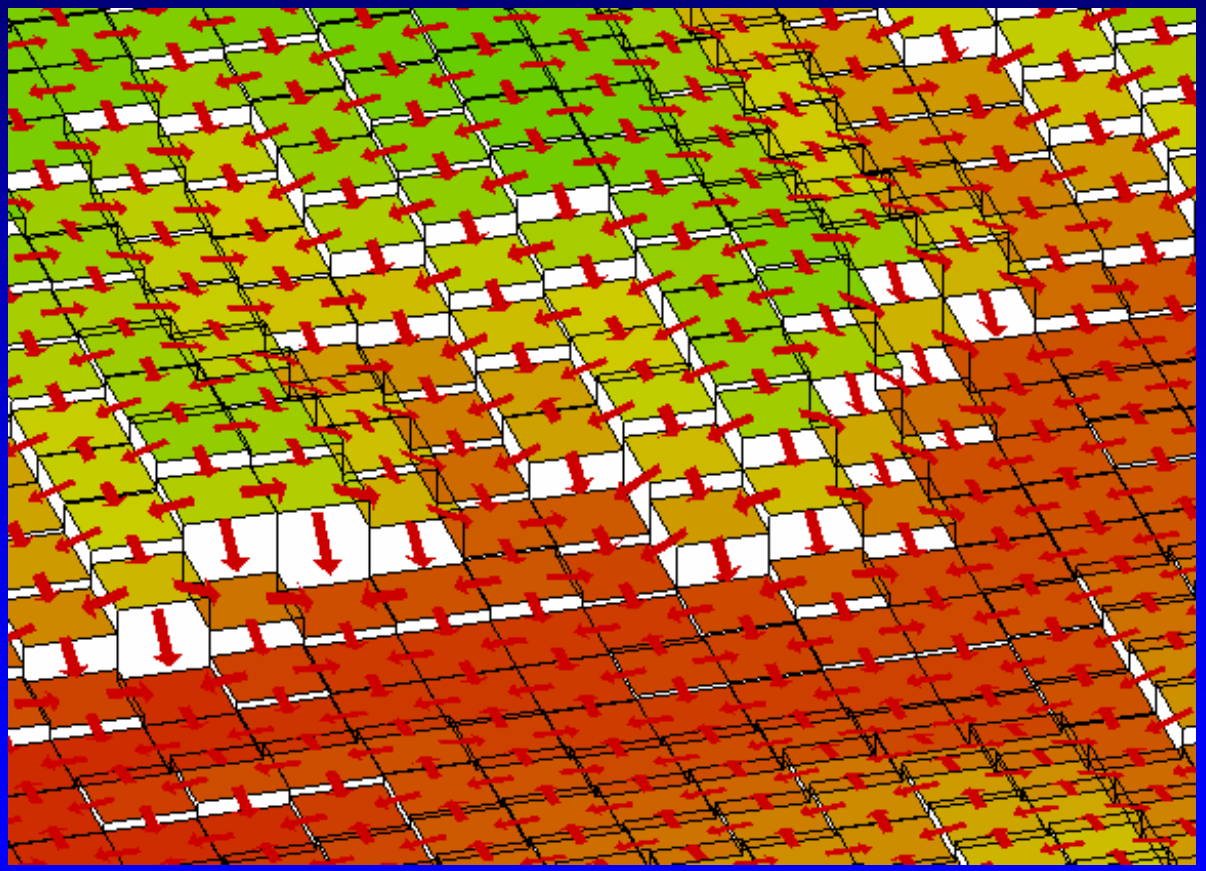
- Uses Land Use, Soil Type Information





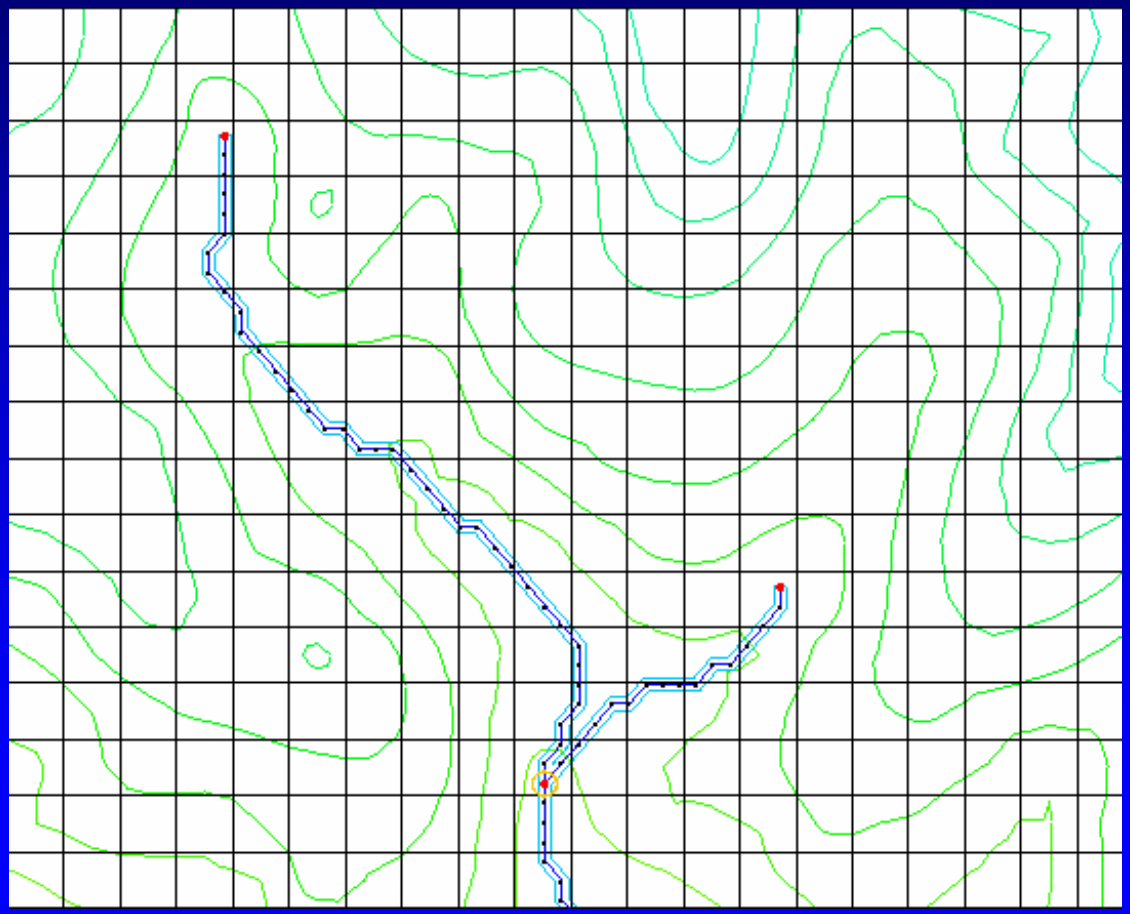
Cell-to-Cell Overland Flow

- 2D Overland Flow



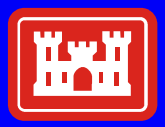
Channel Routing

- 1D Stream Flow



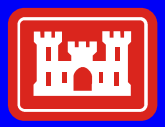
Subsurface Flow

- Infiltration
  - Green & Ampt
  - Green & Ampt with Soil Moisture Redistribution
  - 1-D Richards' Equation
  - Sacramento Soil Moisture Accounting
- 2D Groundwater
  - Full interaction



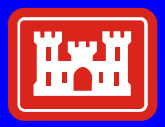
Sources/Sinks

- Precipitation
  - Gage
    - Theissen
    - IDW
  - Radar
- Evapotranspiration
  - Long-term simulation
  - Soil Moisture Accounting

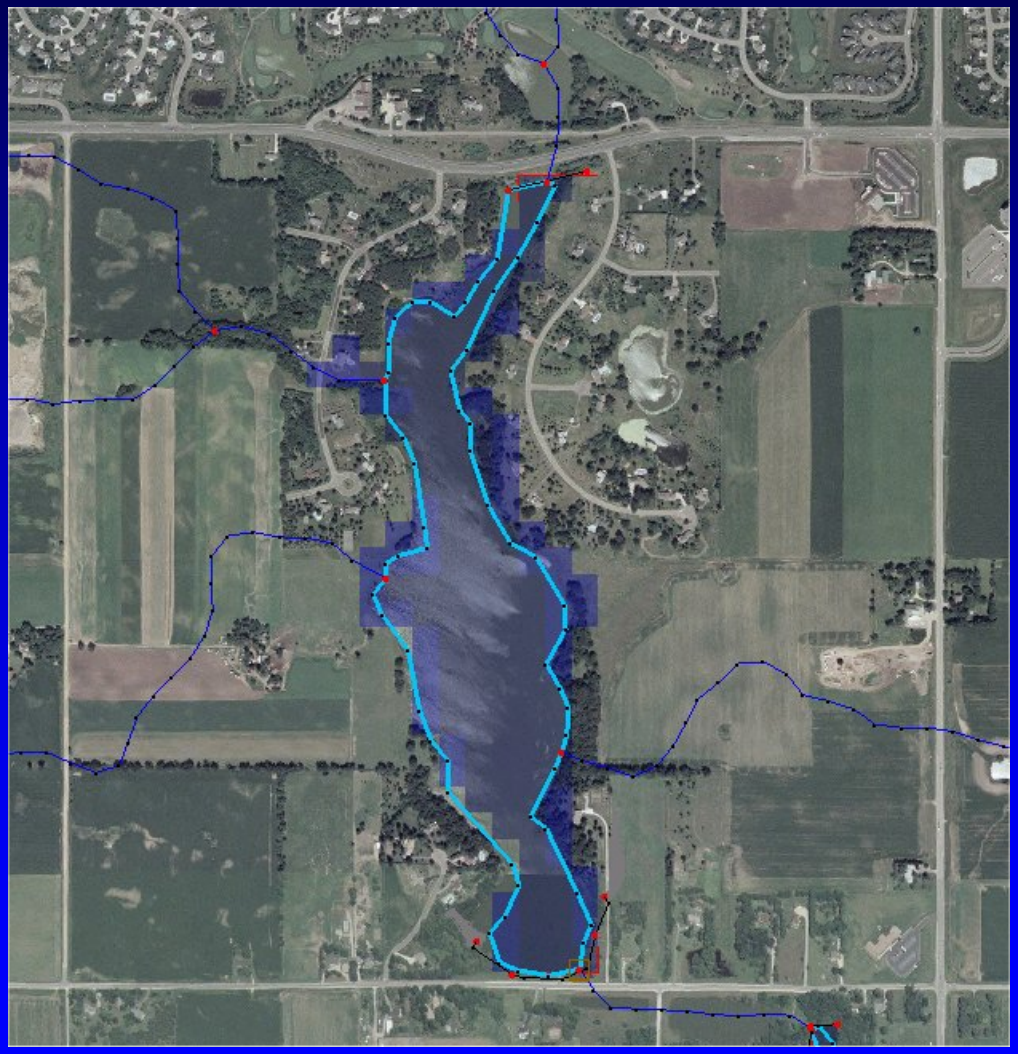


Hydrologic Elements/Options

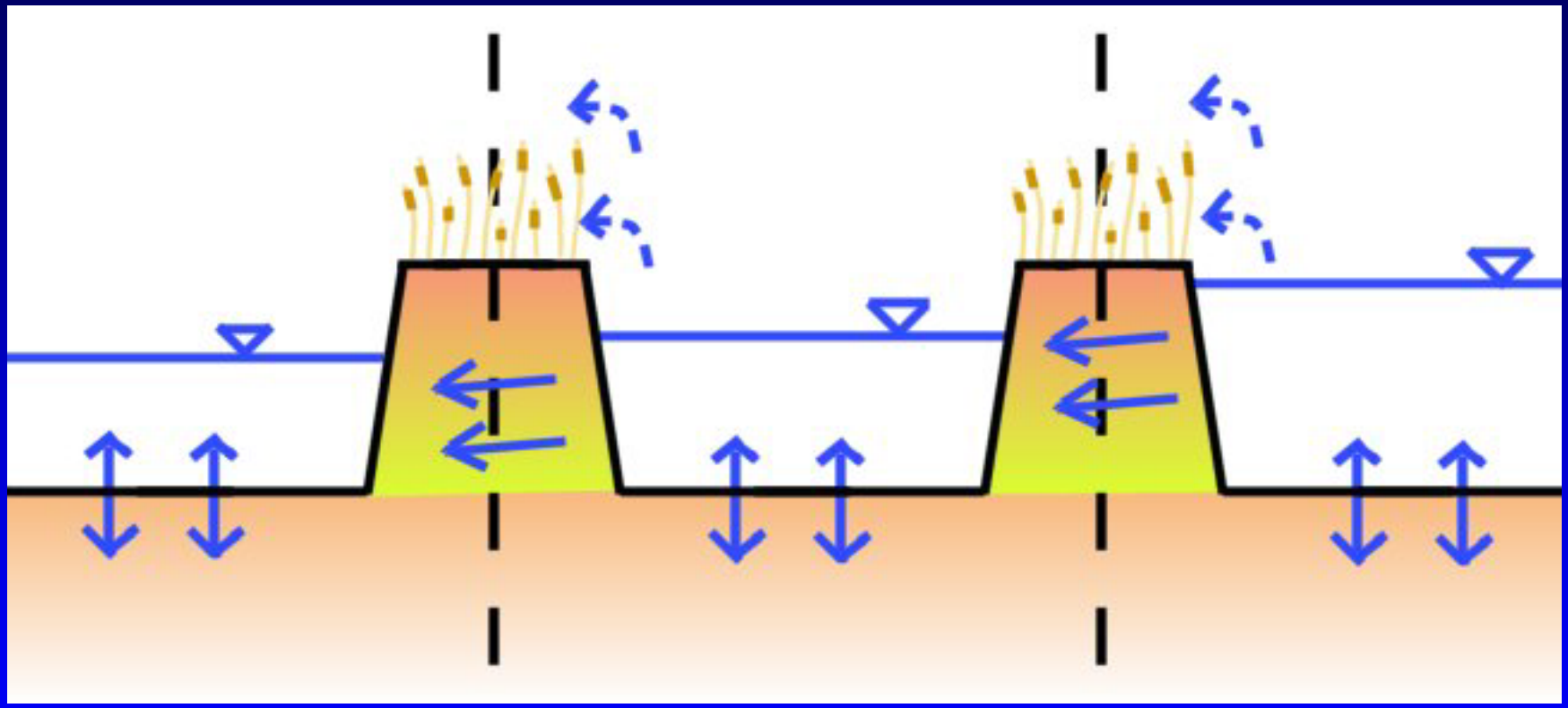
- Lakes & Reservoirs
- Wetlands
- Hydraulic Structures – Culverts, Weirs
- Embankments
- Sediment Erosion and Deposition
- Contaminant Transport
- Storm Pipe, Tile Drain Network



Lakes

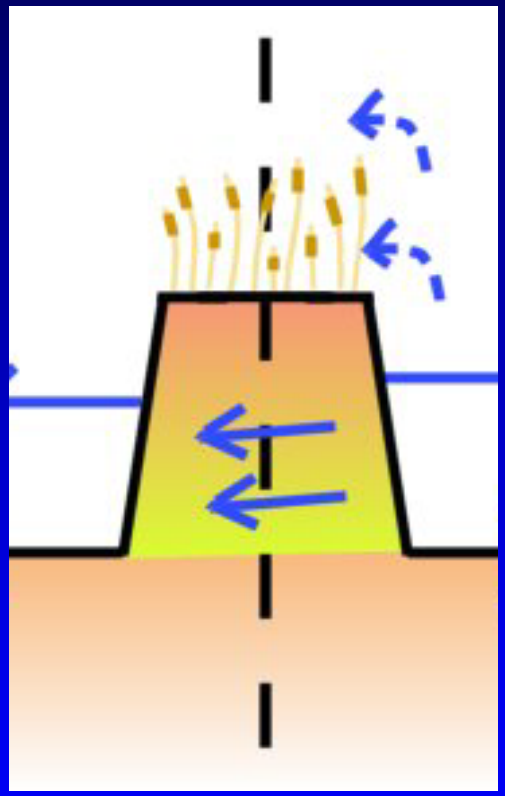


Wetlands



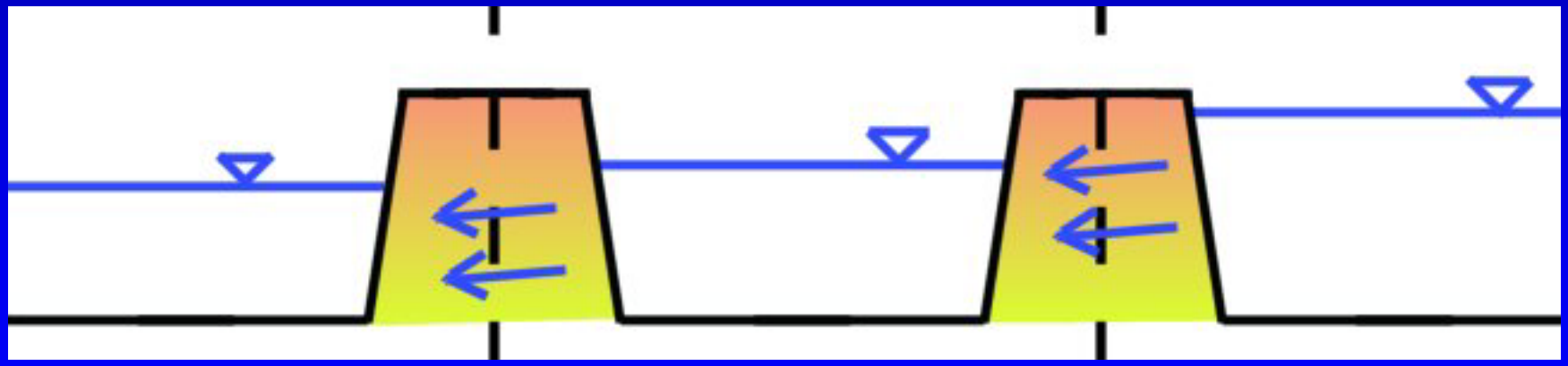
Wetlands

- Specify:
  - Retention Depth
  - Vegetation Height
  - Lateral Hydraulic Conductivity
    - Seepage Face
    - Vegetation
  - Fully Submerged Vegetation Roughness Coefficient



Wetlands

- Flow Through Seepage Face
  - Darcian, Q=kiA
  - Hydraulic gradient from cell center to cell center

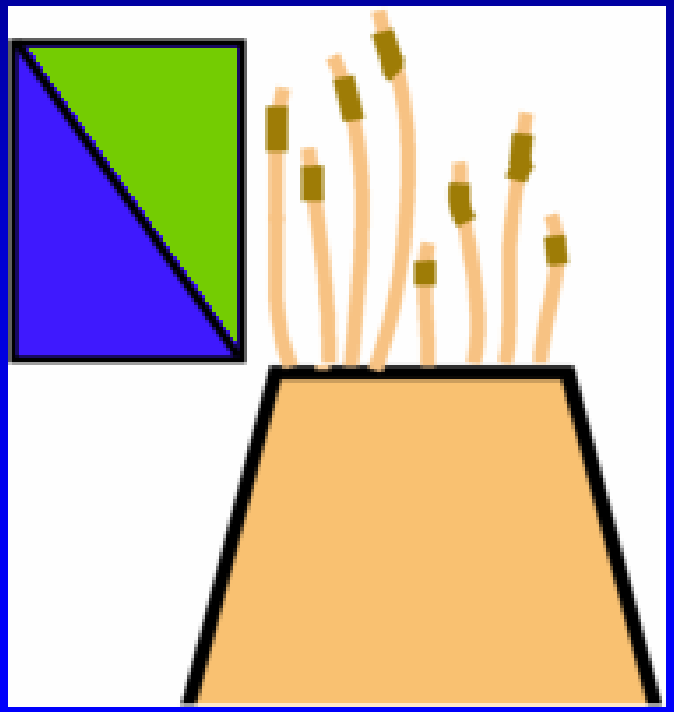


Wetlands

- Overtopping flow (Flow Through Vegetation)
  - Combination of Darcian, Manning's

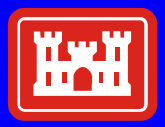
Manning's Flow

Darcian Flow

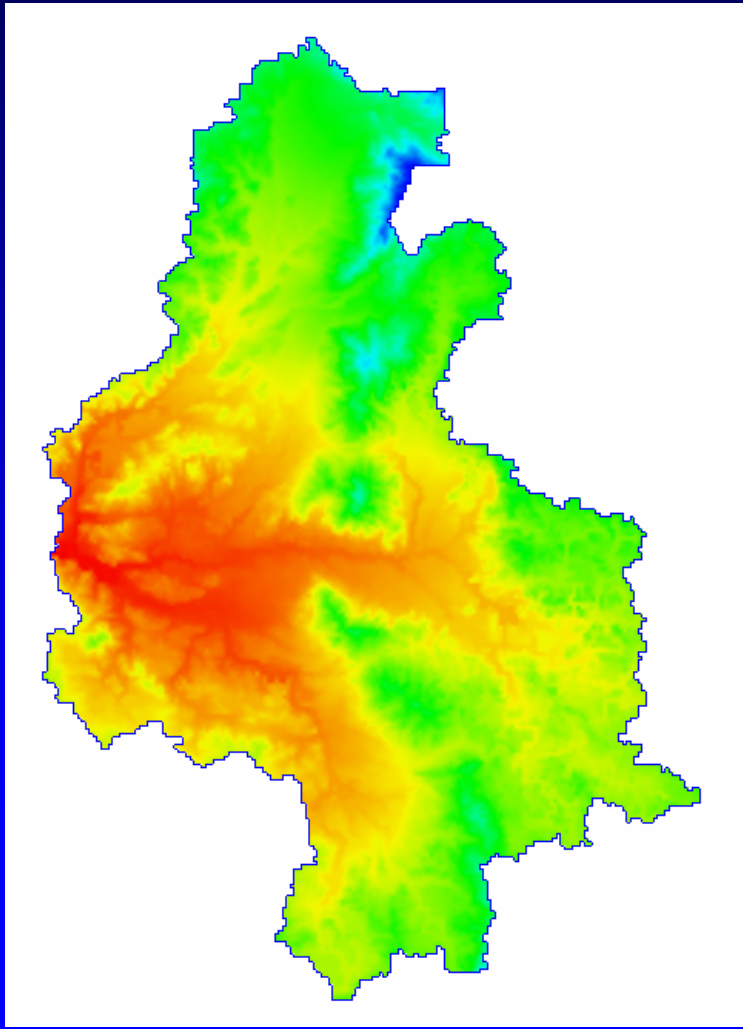


How to Obtain GSSHA

- Fully supported in WMS version 7.x
- http://chl.erdc.usace.army.mil/software/wms



GSSHA Simulation of the Coon Creek Watershed

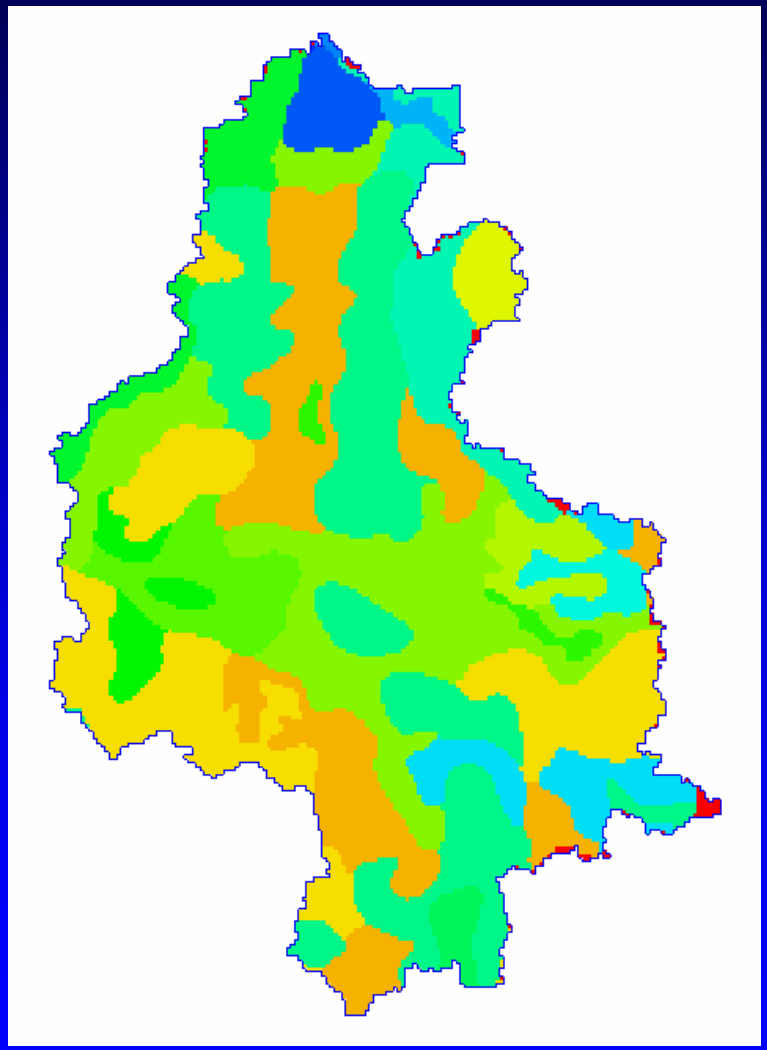


US Army Corps of Engineers

Engineer Research and Development Center

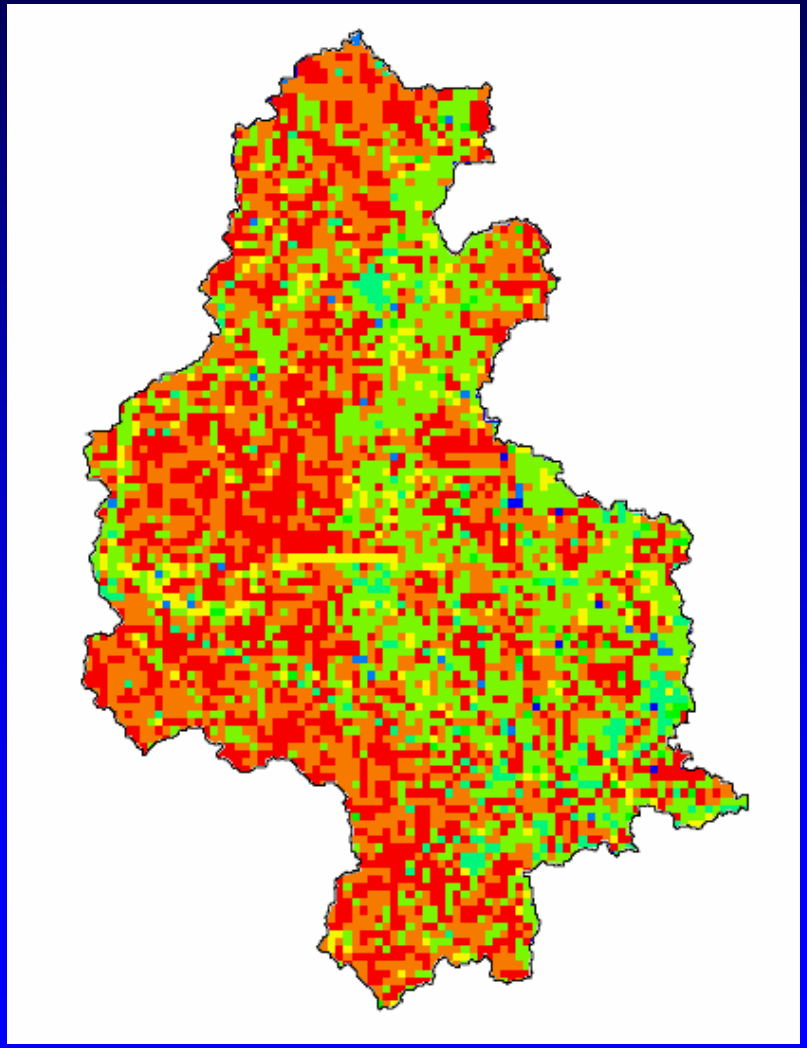
Coon Creek Simplified Soils

- 8 Soil Types
- 3 Subsurface Layers
- Simplified by similar surface, subsurface characteristics



Coon Creek Land Cover (1999)

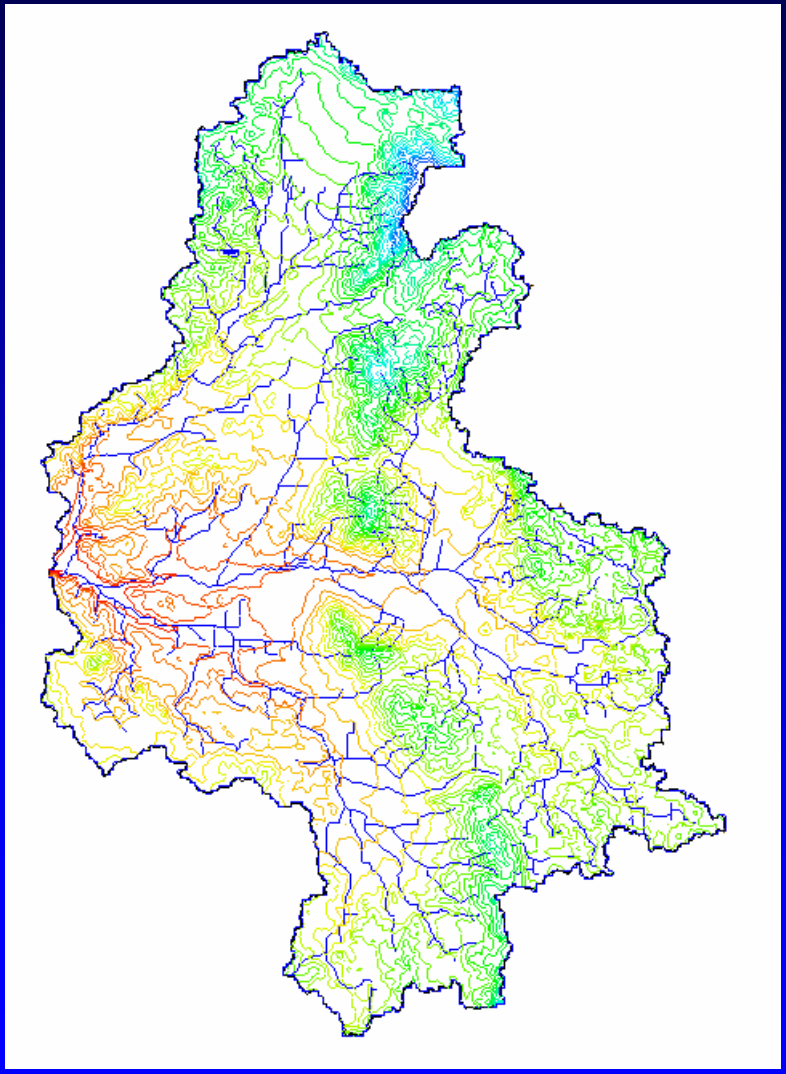
- 6 Classifications
  - Urban
  - Corn
  - Soybeans
  - Forest
  - Wetlands
  - Grassland



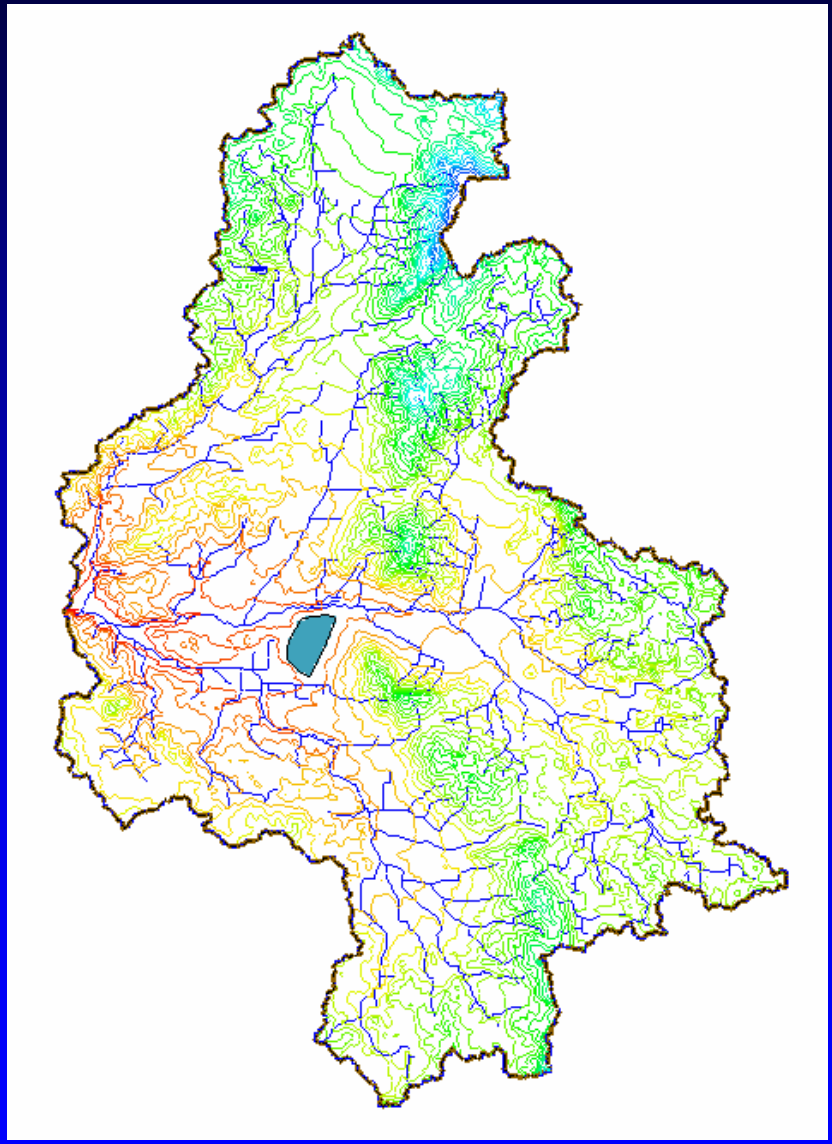
Project Goals

- Develop Watershed Management Plan
  - Placement of 1600 ac of wetlands
  - Removal of tile drain
  - Assess impacts of future land use

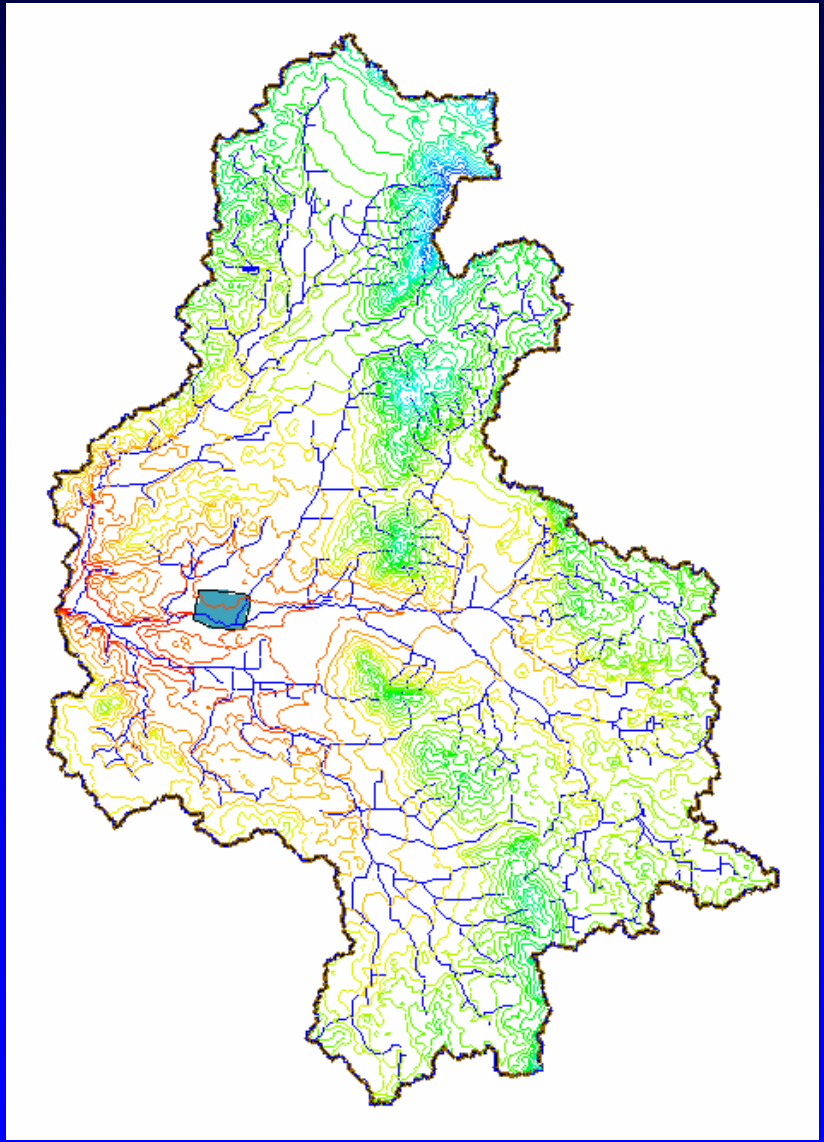
Baseline



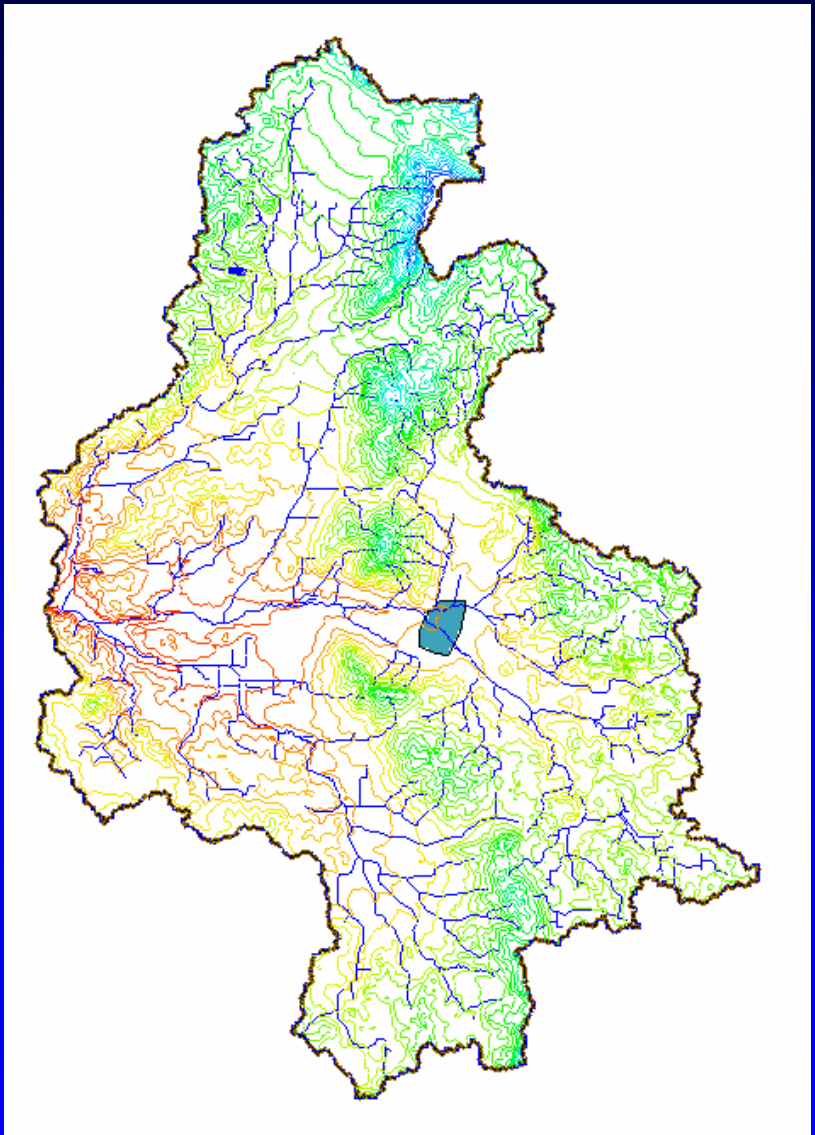
Wetland #1



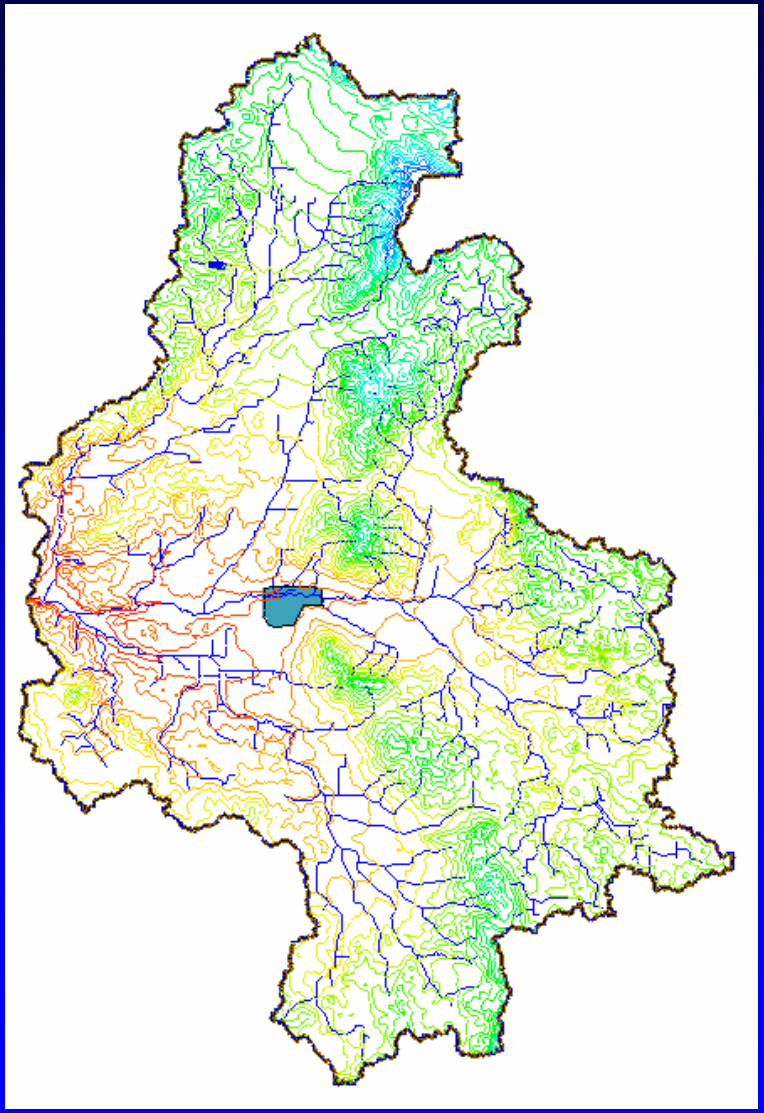
Wetland #2



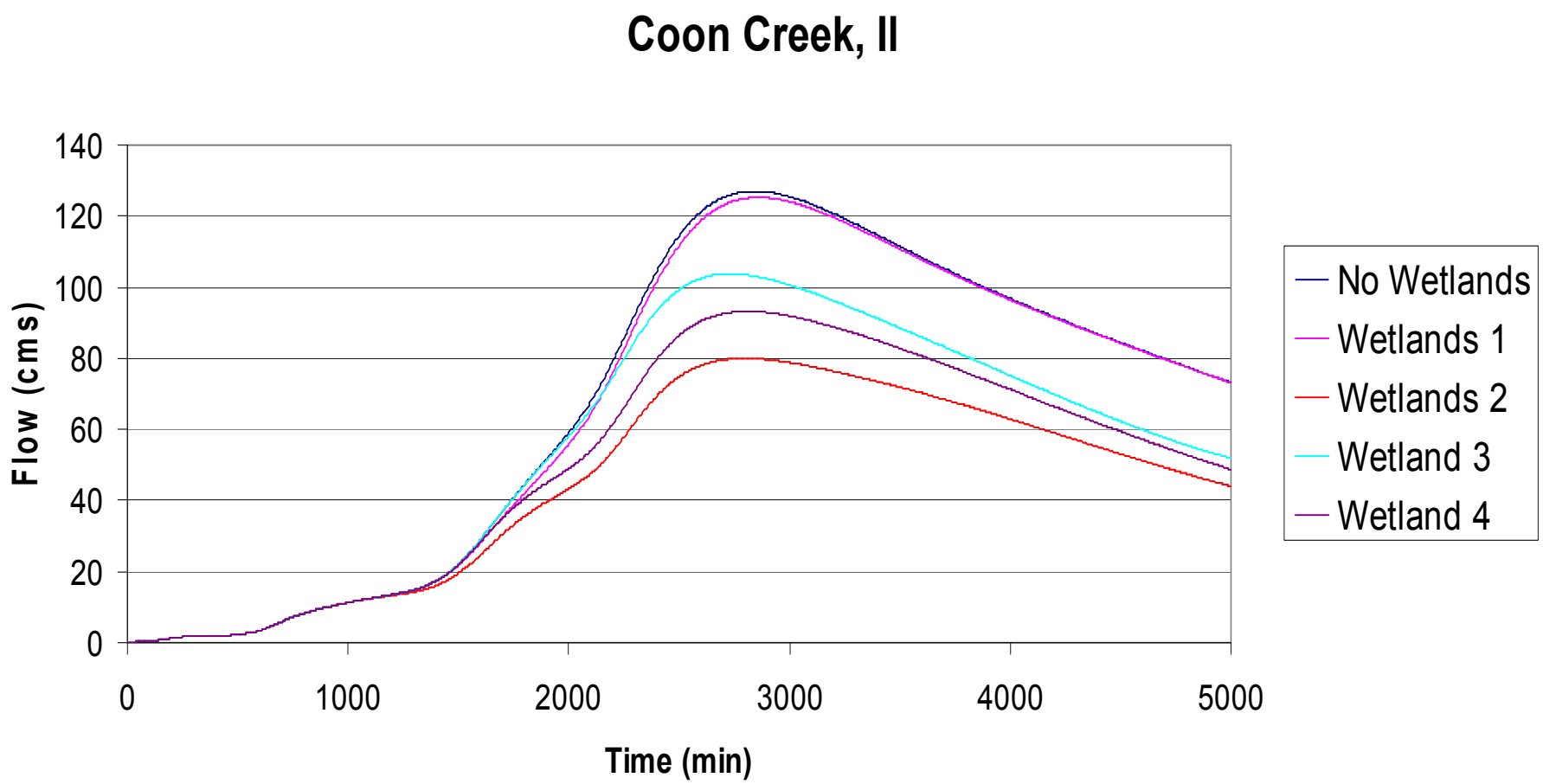
Wetland #3



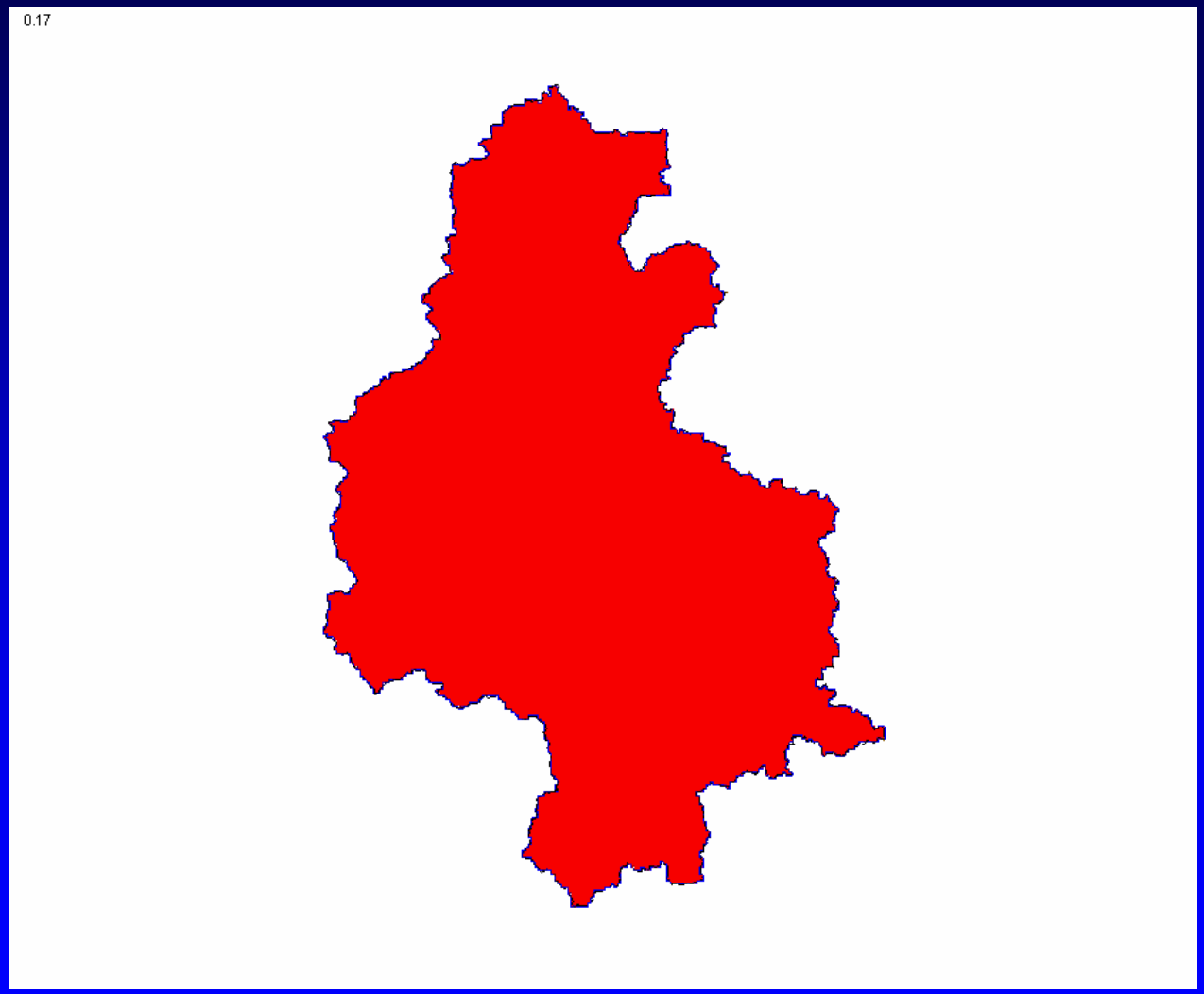
Wetland #4



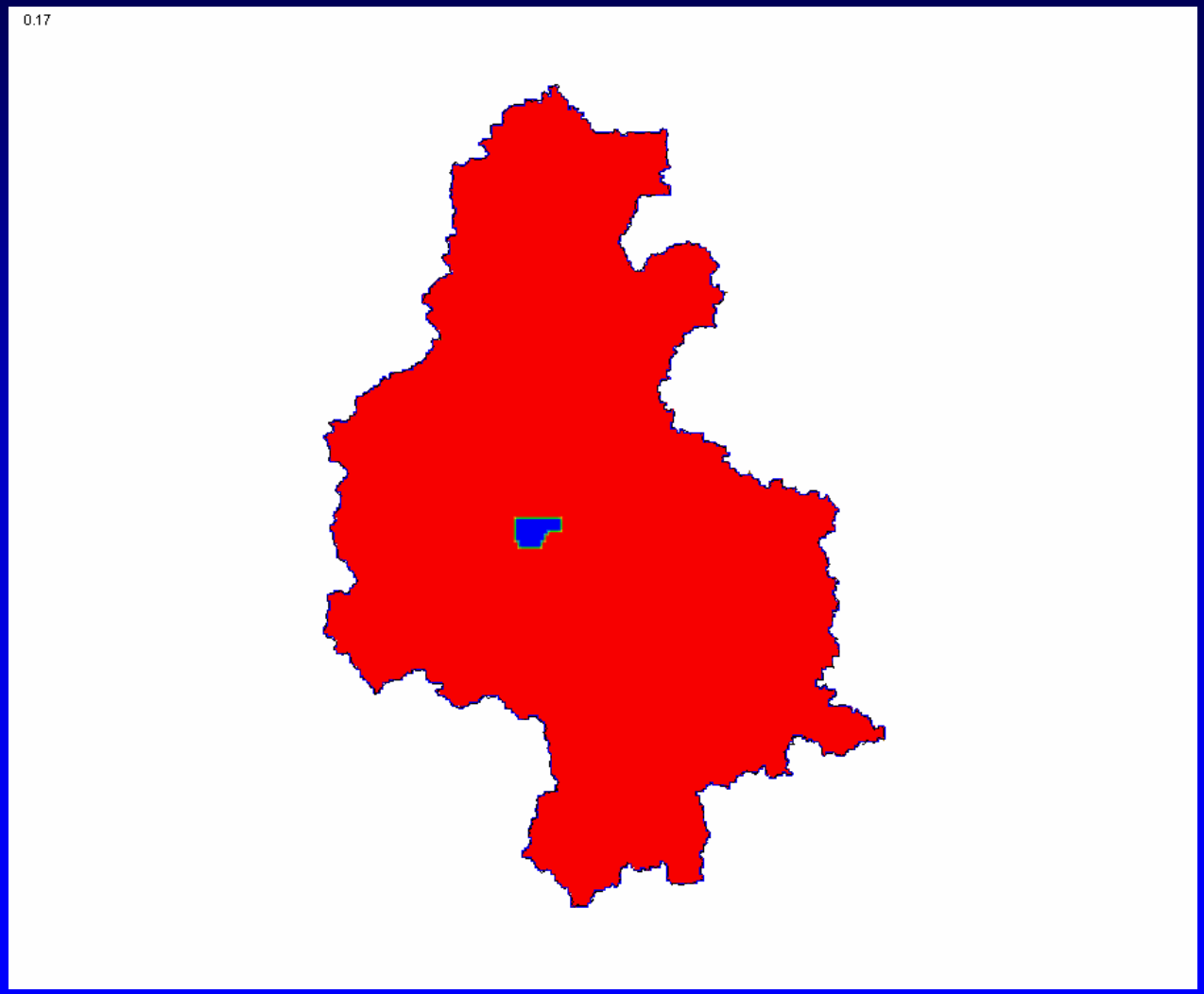
Results


Coon Creek, Il
Flow (cms)
140
120
100
80
60
40
20
0
0
1000
2000
3000
4000
5000
Time (min)
No Wetlands
Wetlands 1
Wetlands 2
Wetland 3
Wetland 4

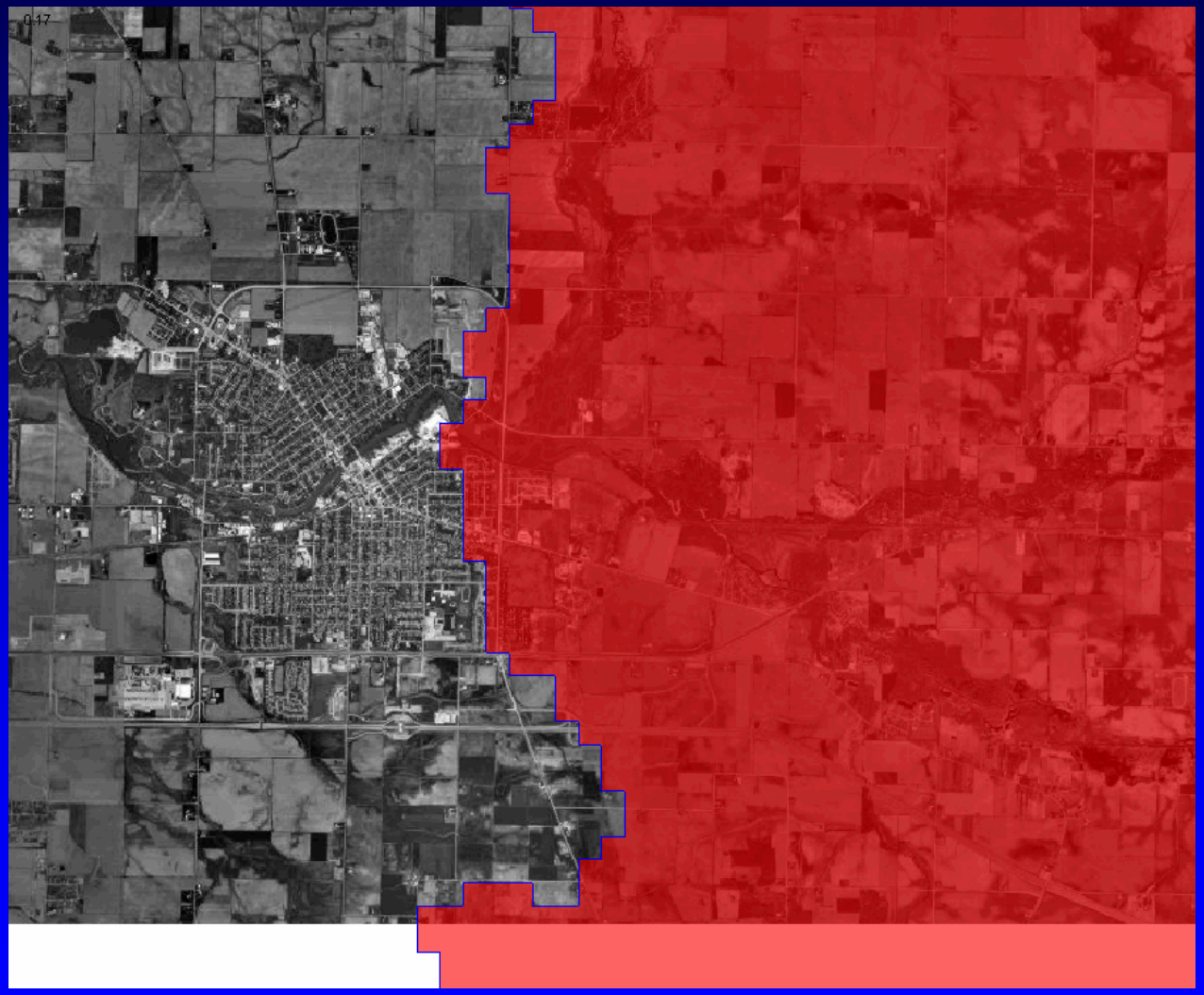
Baseline AVI



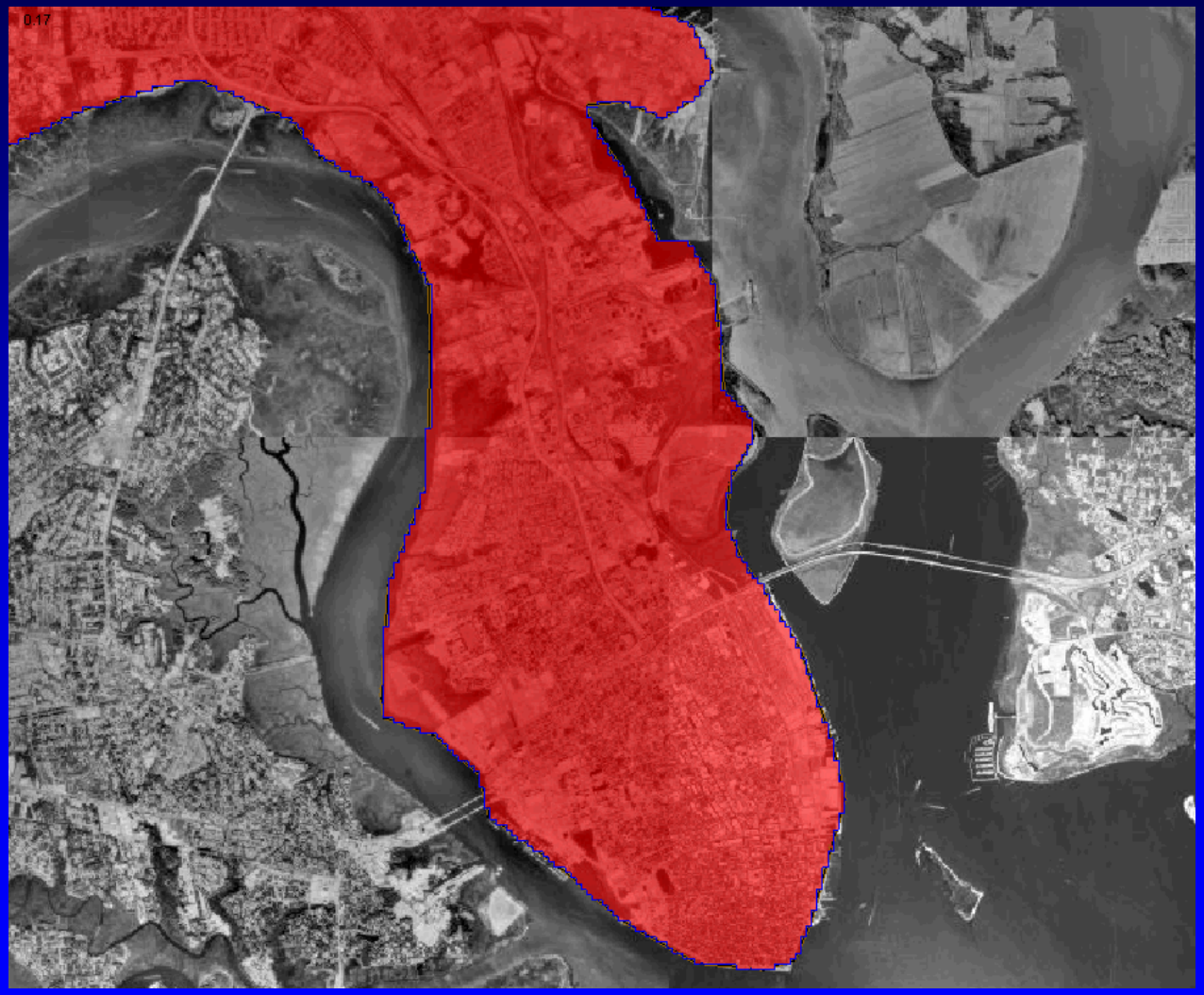
Wetlands #4 AVI



Close-up of Baseline



Bonus: Storm Surge Modeling



Questions? Comments?

Aaron.R.Byrd@erdc.usace.army.mil