Section 5. Chesapeake Bay Network Generation

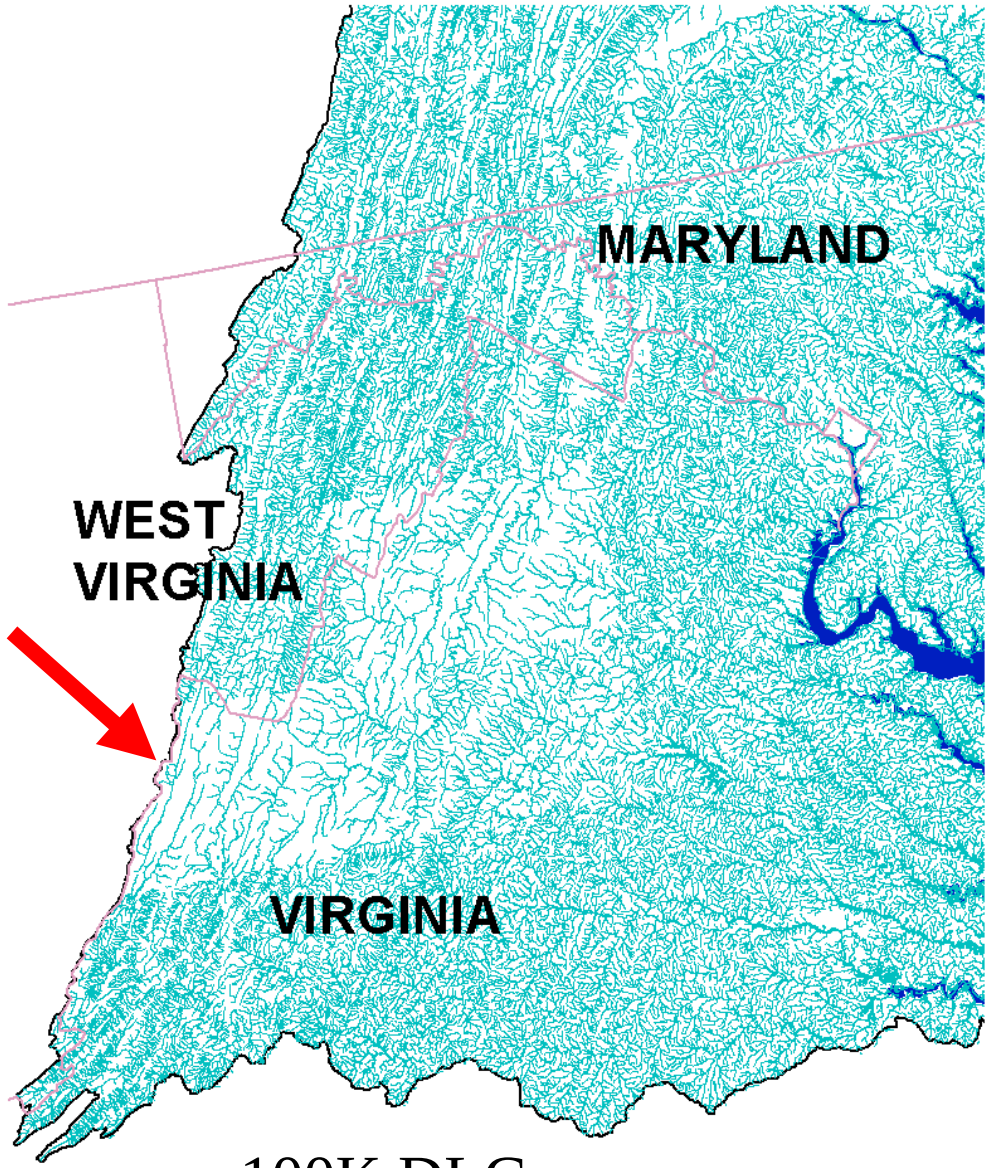
- CB watershed
  - ~ 64,000 square miles
  - ~ 166,000 square kilometers
- Constructed 3 models
- Version I
  - ERF1, ~1300 stream reaches
  - 1K DEM
- Versions II and III
  - Stream and watershed network created from 30m DEM
  - Used ERF1 stream-characteristics
  - ~1400 stream reaches (not including shoreline areas)

ERF1 Reach File is Building Block

- Stream Reach Characteristics
  - **Mean streamflow**
  - **Mean velocity**
  - **Travel time**
  - **Unique reach ID**
- Networked Topological Properties
  - Trace up and down stream
- Relative Consistent Density

100K Issues

- Stream Density
- No Stream Reach Characteristics



100K DLG,
RF3 & NHD

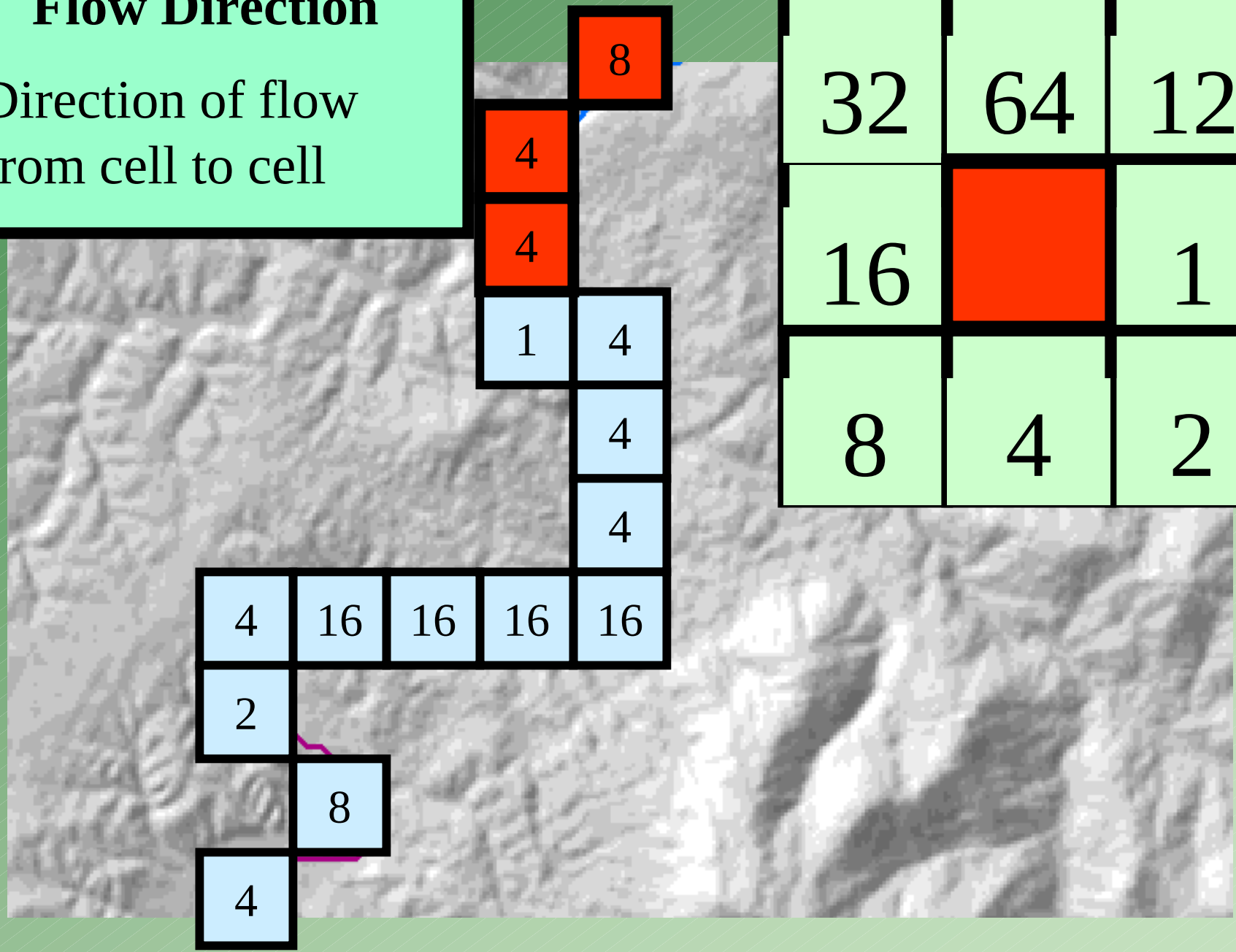
CHESAPEAKE BAY NETWORK GENERATION

VERSION II, 1992

- Generate New Stream Network
  - Flow Direction from 30m DEM (NED)
  - Flow Accumulation > 5000 cells = New Reach
- Add/Correct Reaches
- Select Out Reaches Corresponding to RF1
- Conflate ERF1 Attributes to New Reach Network
- Add Nodes to Reach at Monitoring Station
- Divide Shoreline in Arbitrary Locations
- Generate Watershed Boundaries for Each Reach
- Estimate Travel times for New Reaches and Shoreline

Flow Direction

Direction of flow from cell to cell



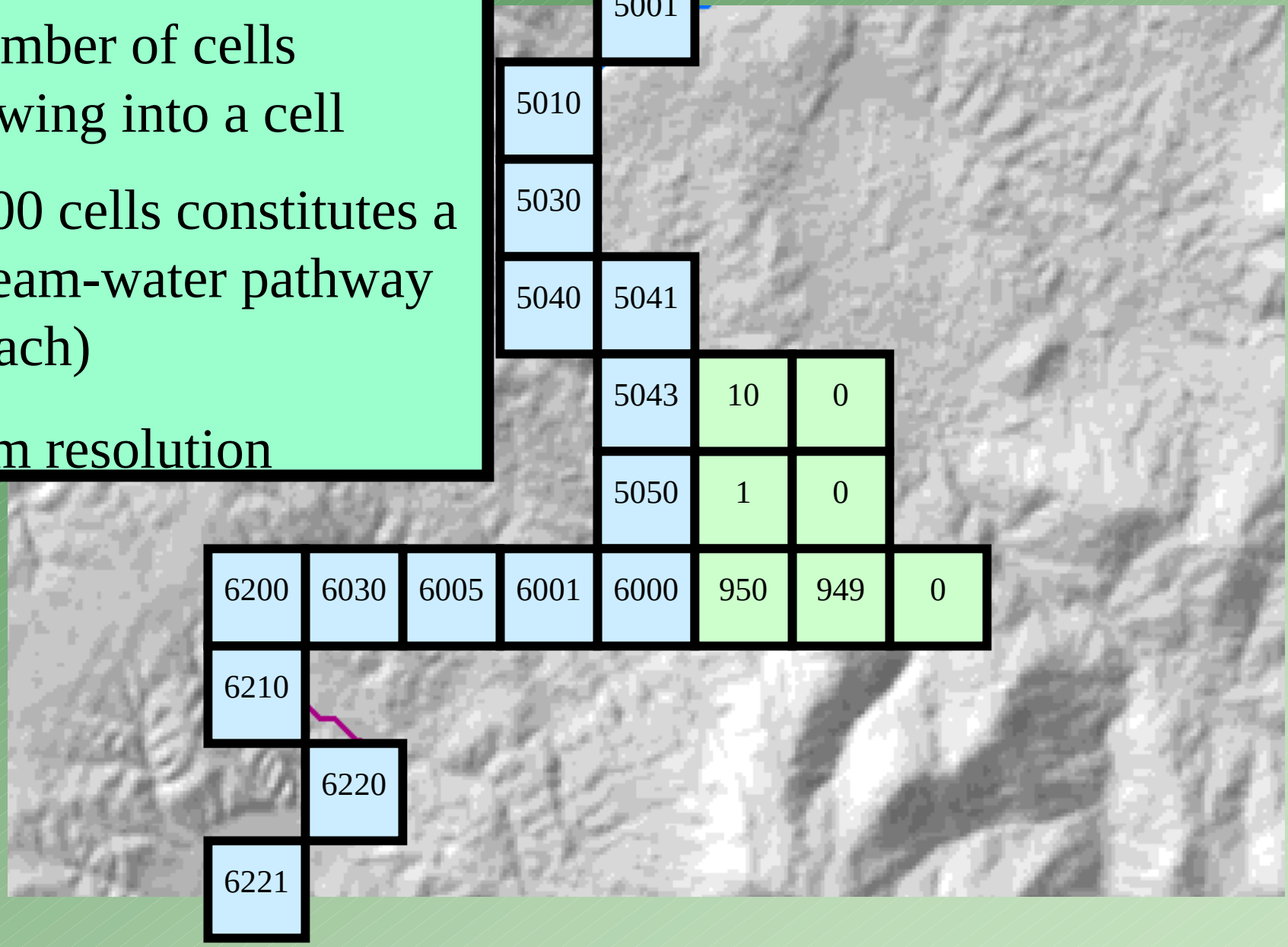
32	64	12
16		1
8	4	2

Flow Accumulation

Number of cells flowing into a cell

5000 cells constitutes a stream-water pathway (reach)

30m resolution

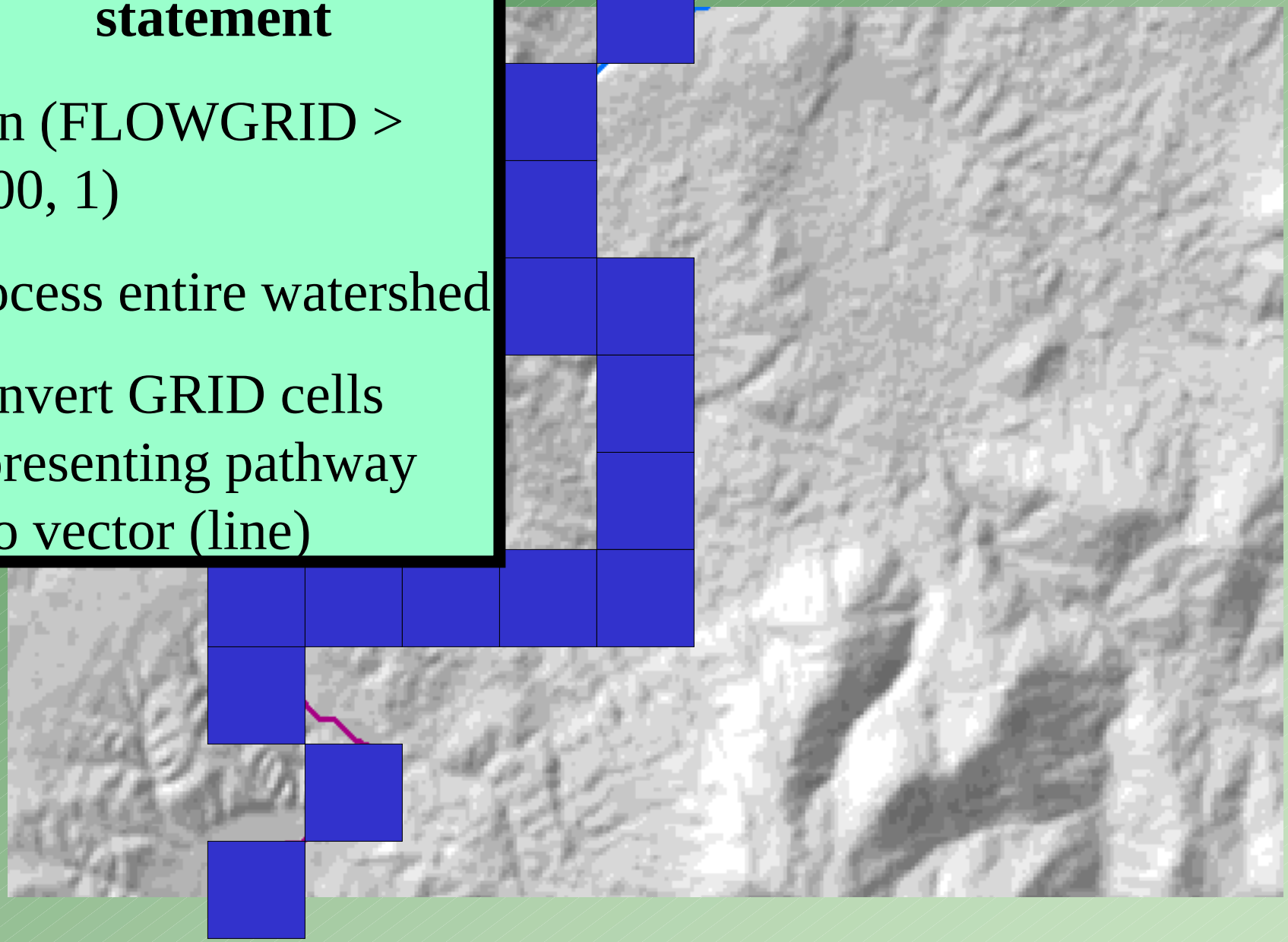


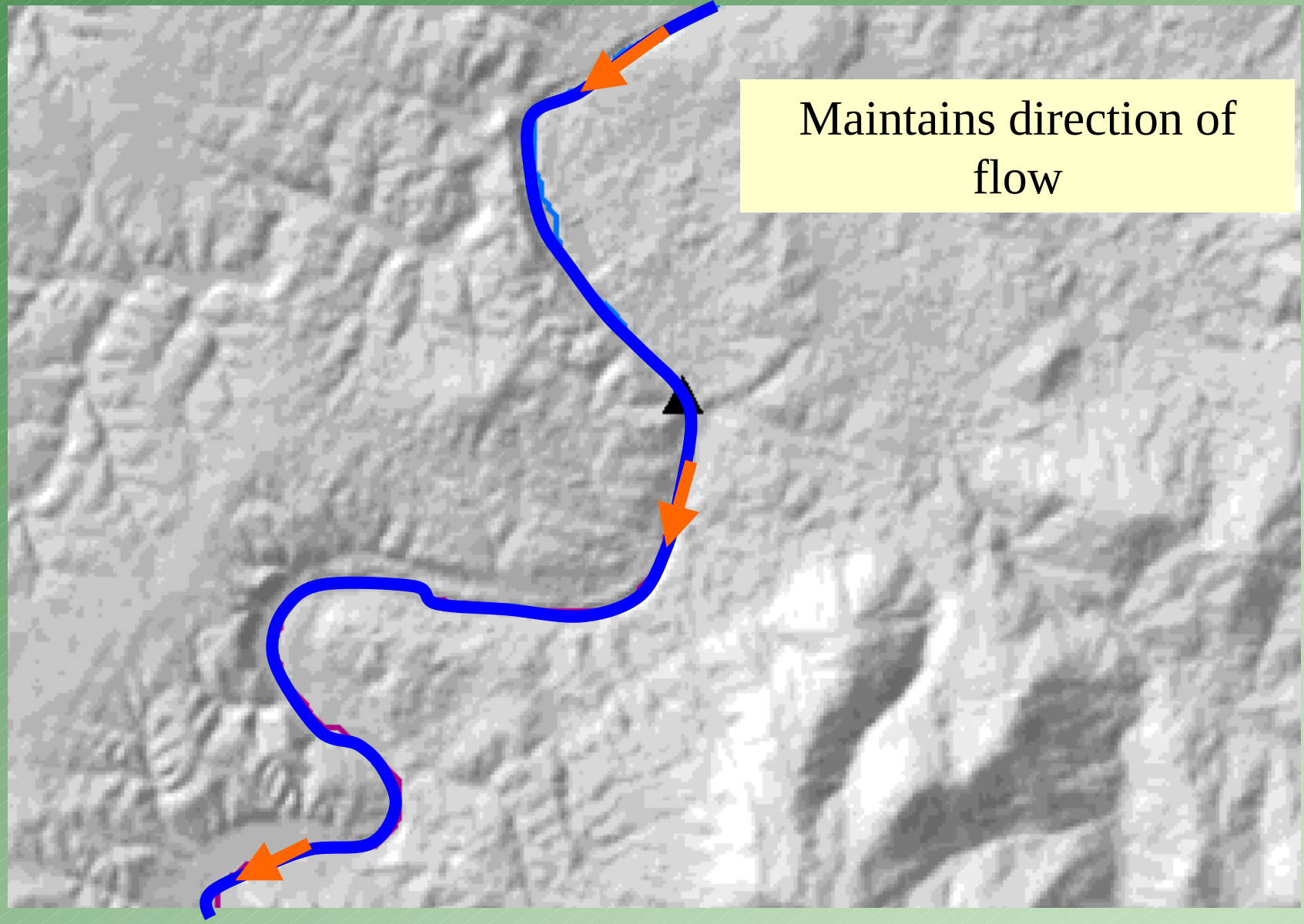
GRID Condition statement

Con (FLOWGRID > 5000, 1)

Process entire watershed

Convert GRID cells representing pathway into vector (line)

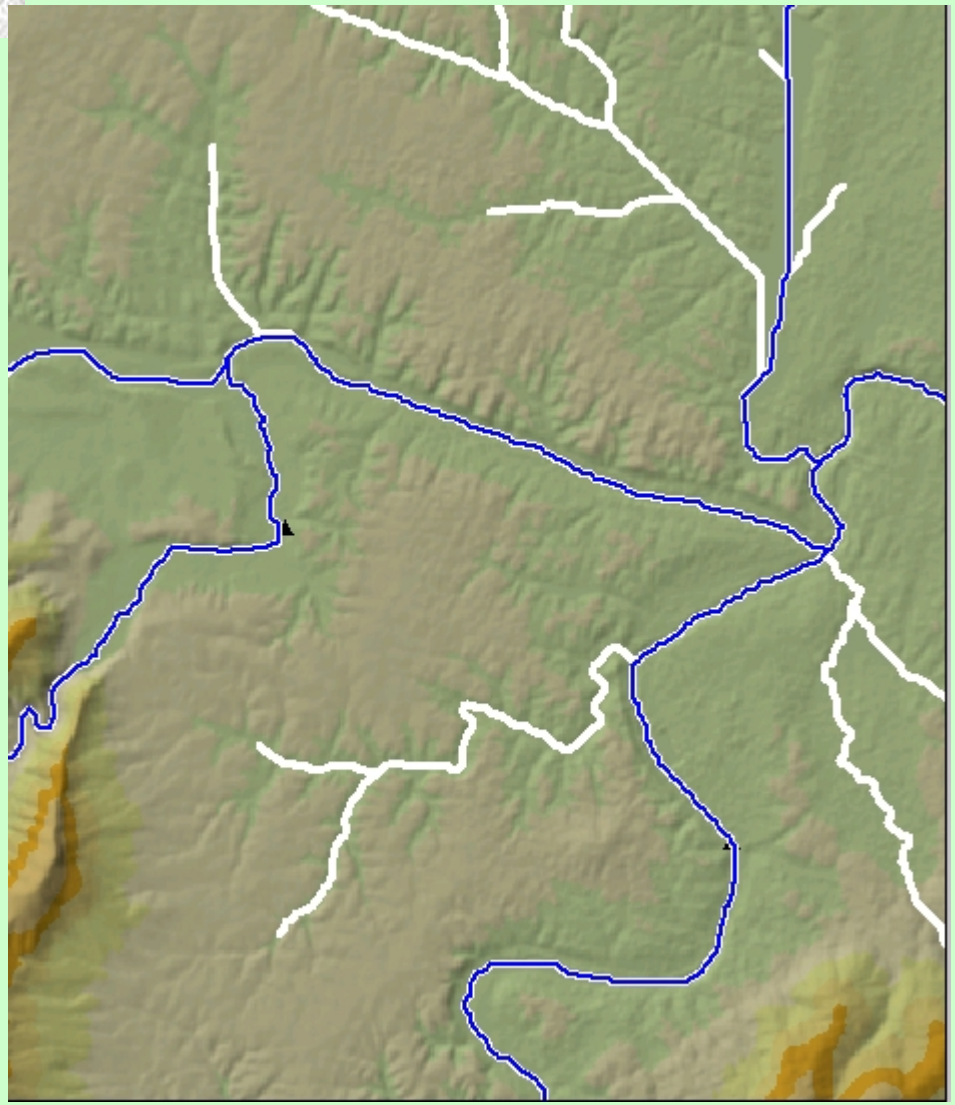



Maintains direction of flow

New Stream Reach Generation

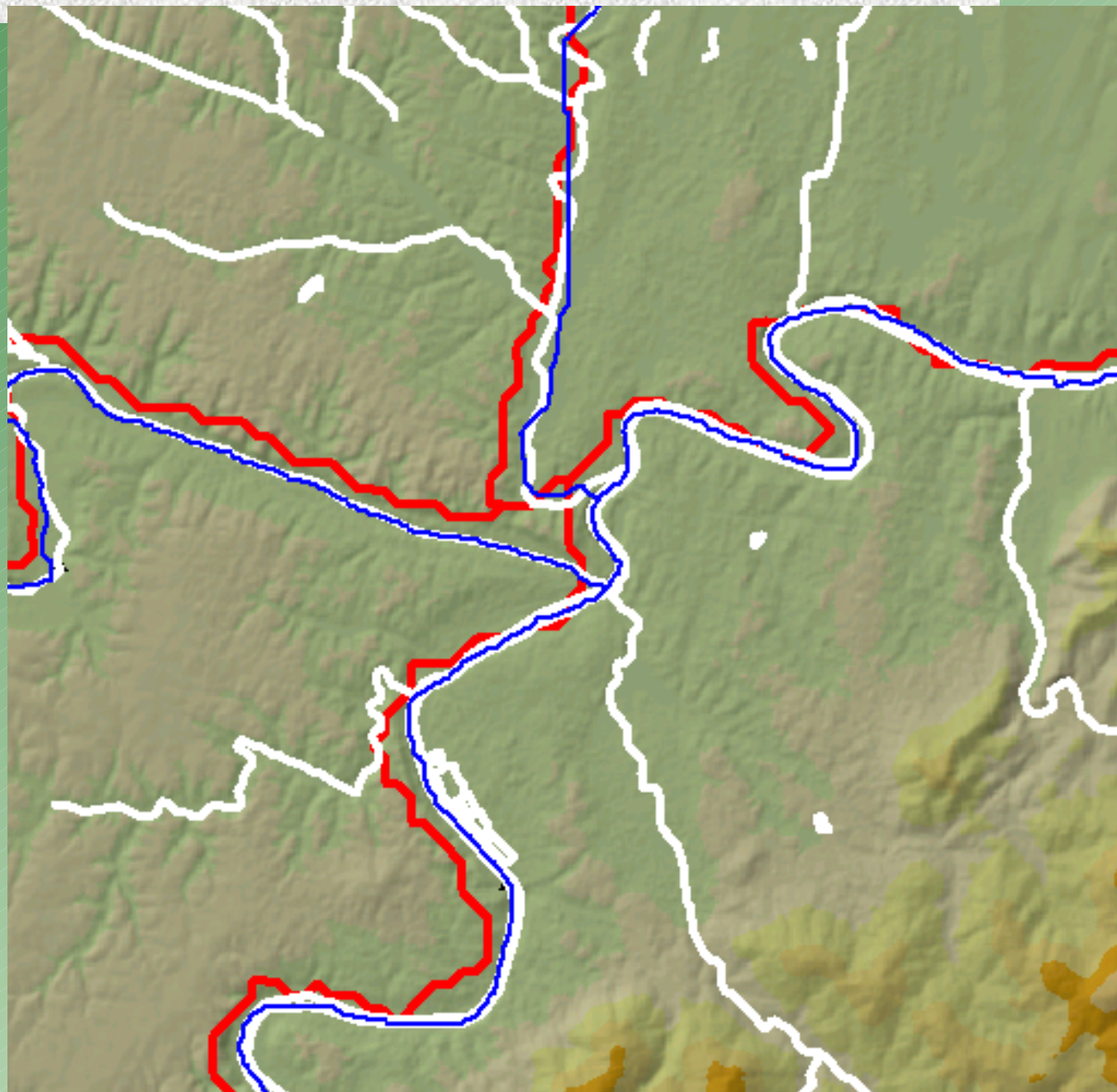
- Stream Channel now Corresponds with Topography
- Produces more than necessary
- Used for stream density variable
- White – “New Streams”
- Blue – Keep for Model

Box Area ~ 209 km2



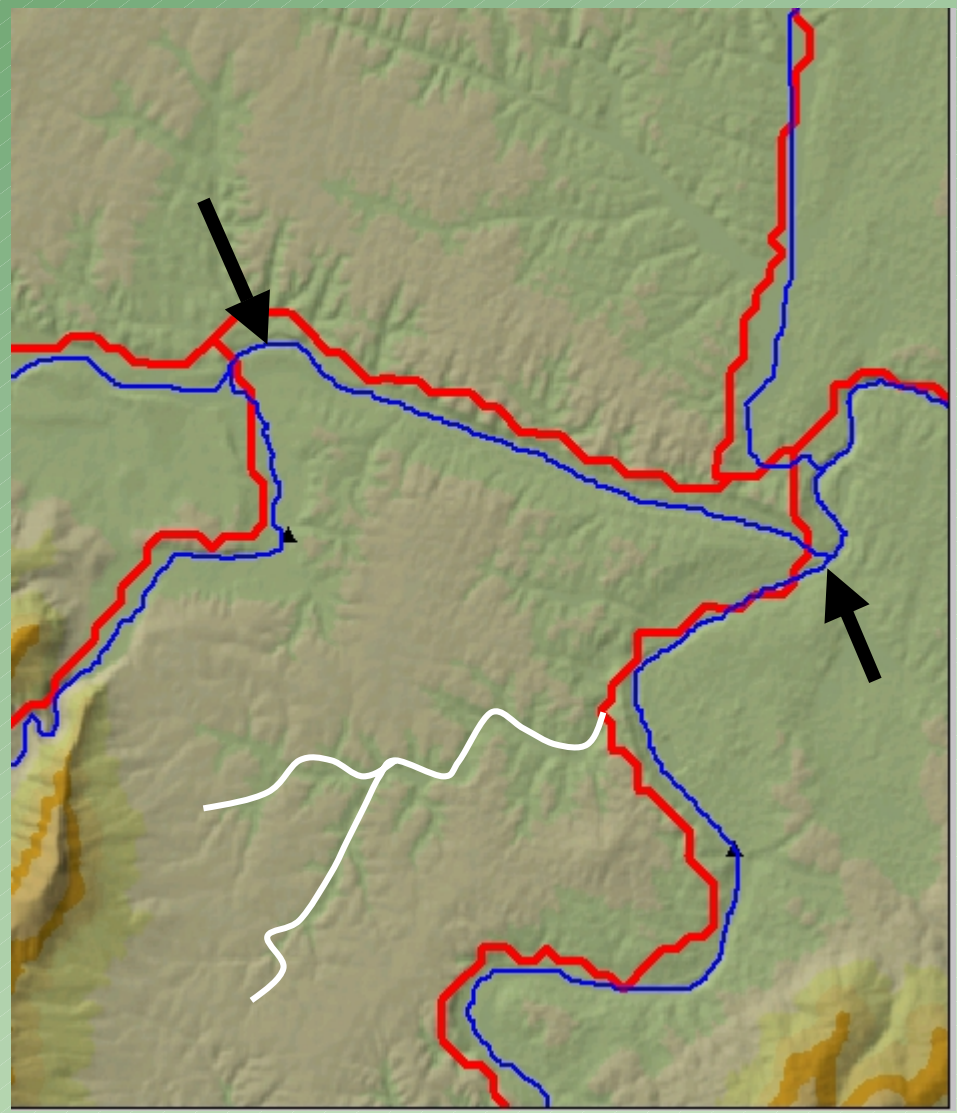
100k NHD, RF1, and New Reach Network

- White – 100k
- Red – RF1
- Blue - New



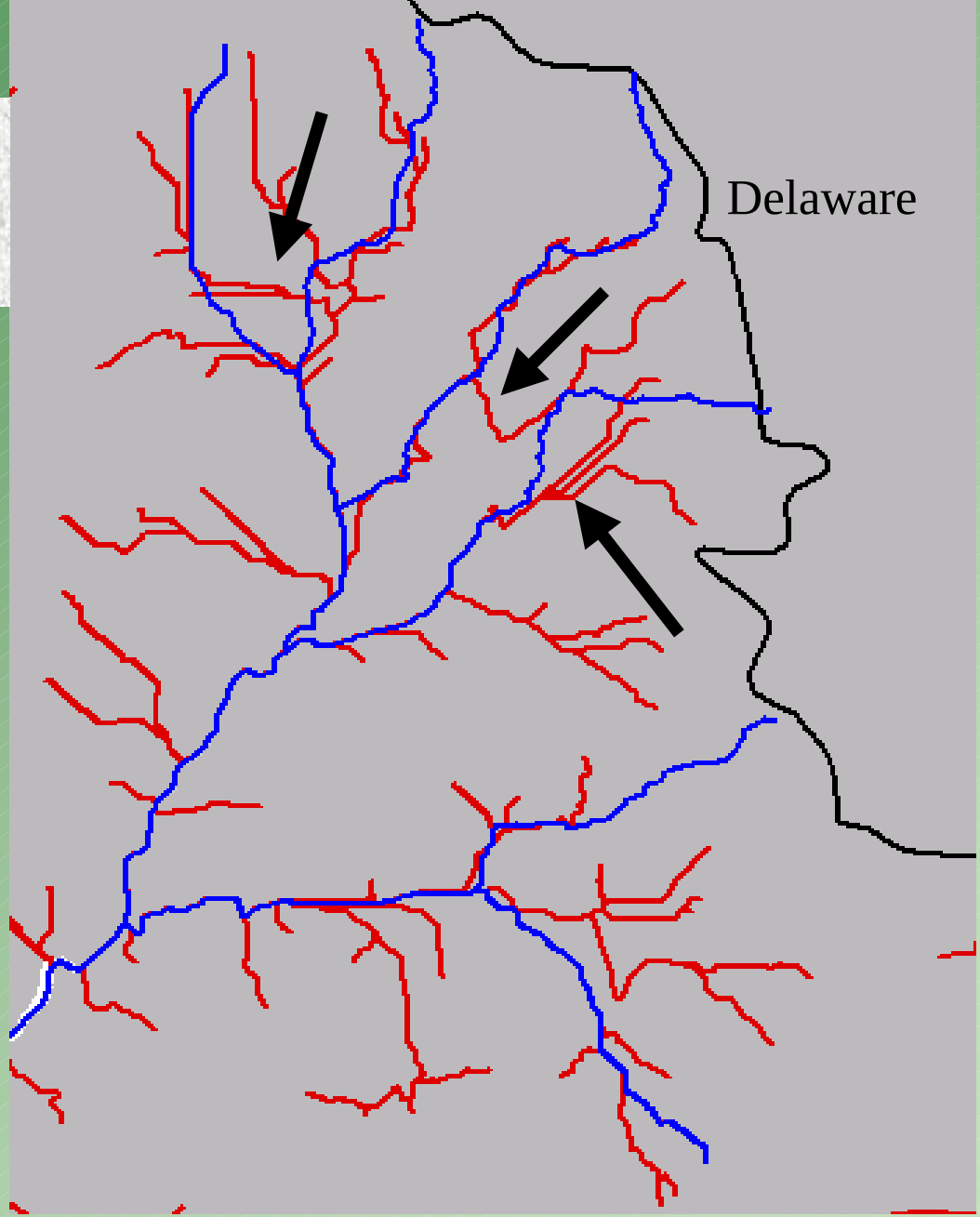
Selecting Main Stream Channel

- Select and keep main water channel relevant to RF1 scale
- Corrects location of streams
- ½ km offset
  - Red – RF1
  - Blue – New Stream Network

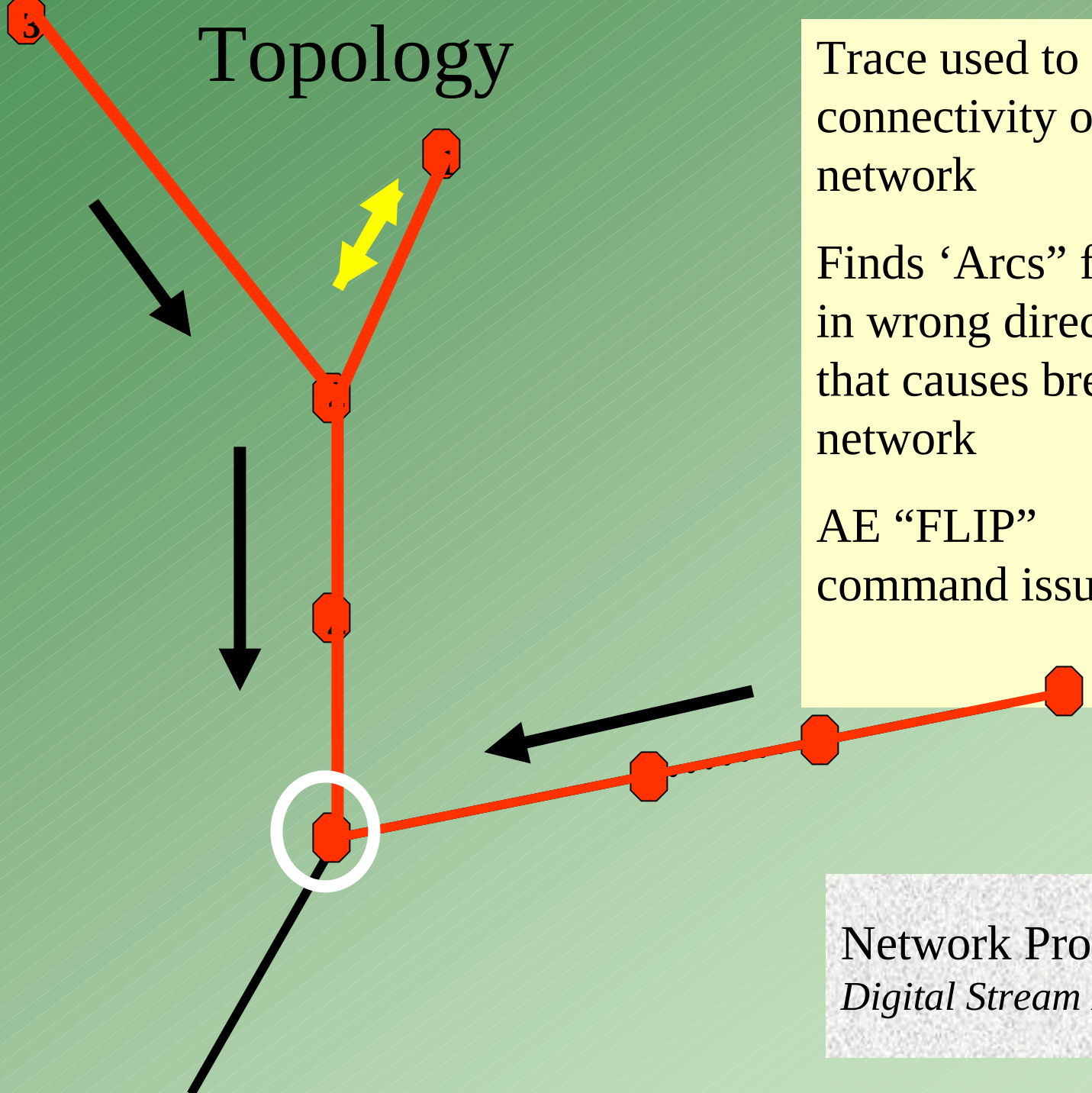


Add/Correct Reaches

- Eastern Shore Nanticoke R.
- Ditching
- Very Flat
- Used 100k for corrections
- Wide Rivers and Reservoirs



Topology



Trace used to check connectivity of network

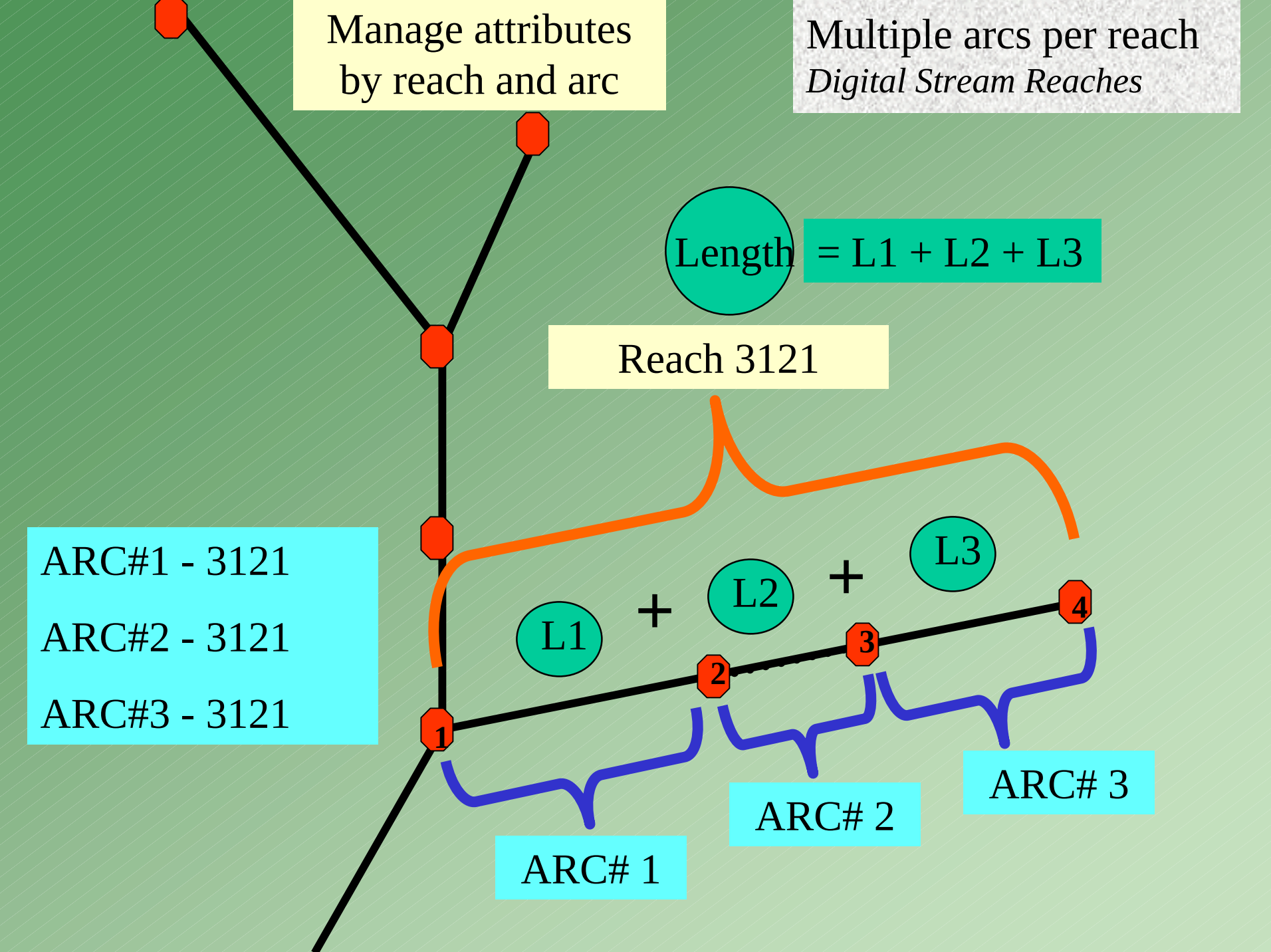
Finds ‘Arcs” flowing in wrong direction that causes break in network

AE “FLIP” command issued

Network Properties
Digital Stream Reaches

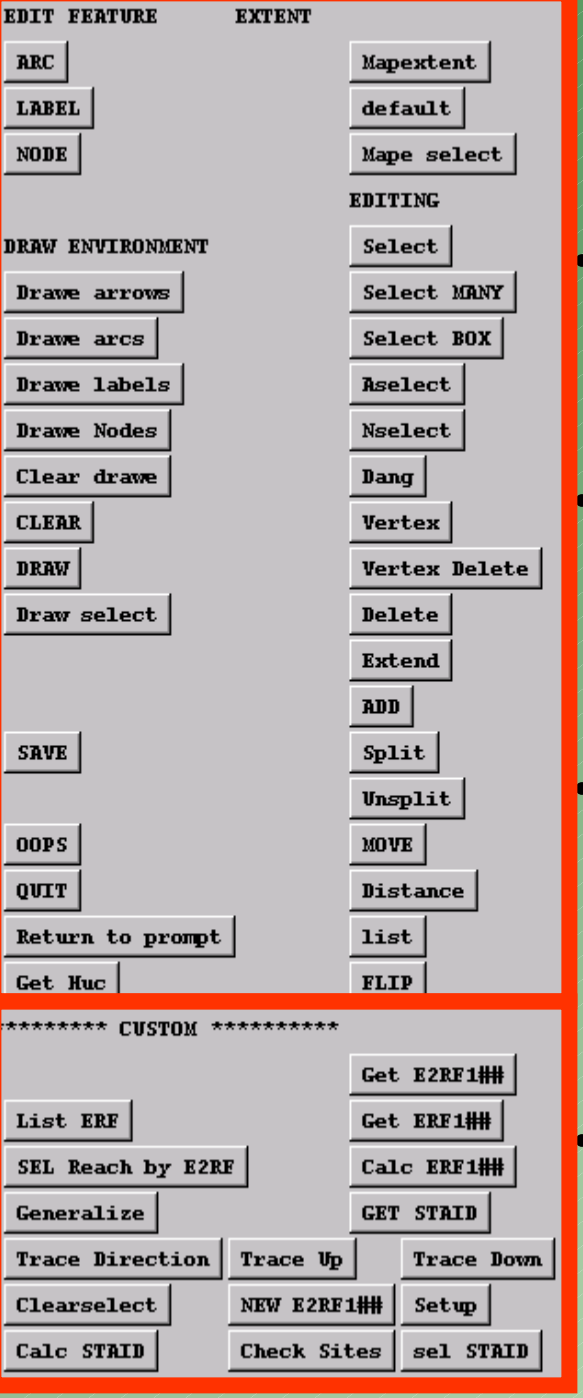
Manage attributes by reach and arc

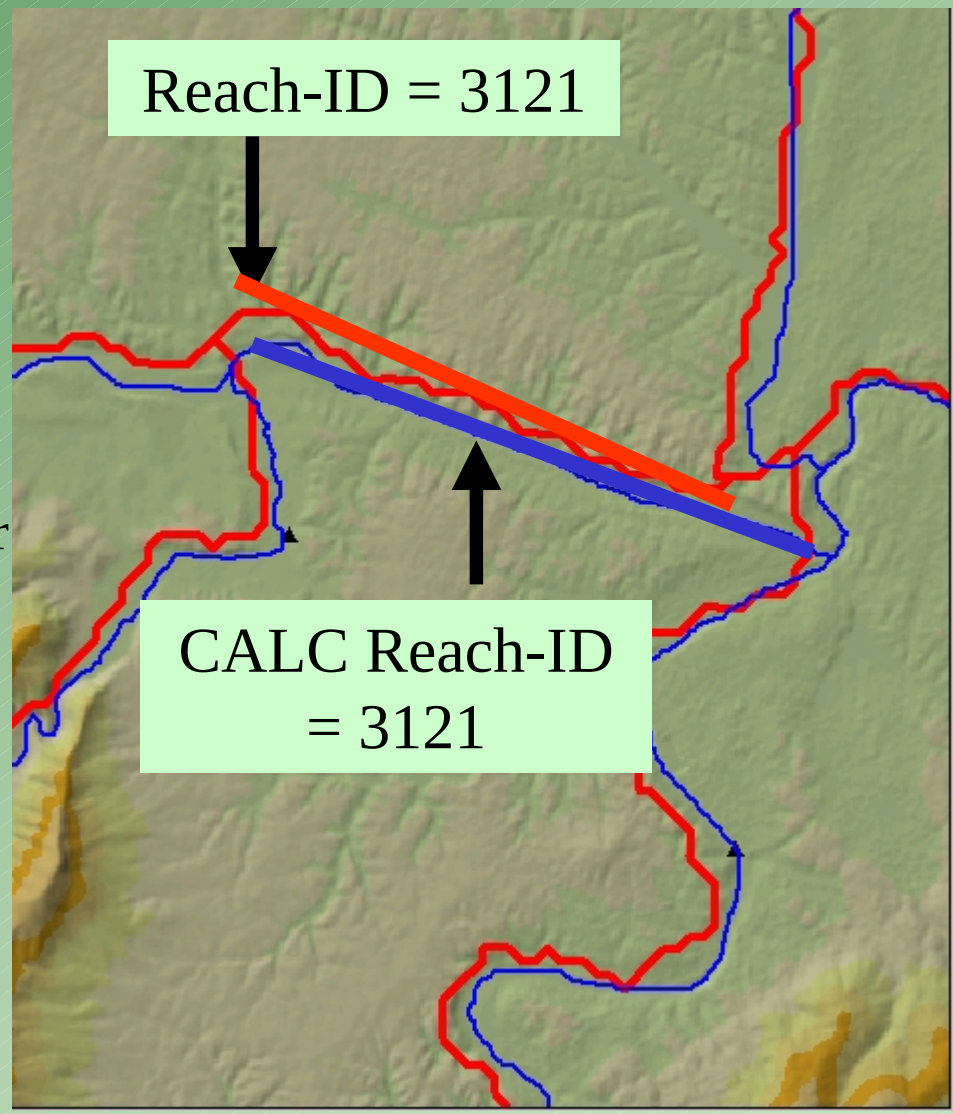
Multiple arcs per reach
Digital Stream Reaches



Conflation of Attributes

- AML/Menu interface in ArcEdit
- Select RF1 (ERF1) reach to obtain unique number
- Select new reach & establish one-to-one relationship
- Relate file & transfer attributes





Network Construction
Spatially Referencing Monitoring Stations

- Adding Nodes at Station Locations (Split.aml)
- Attributing Reaches with STAID (Split.aml)
- Attributing Unique Reach ID (ERF number) (Split.aml)
- Attributing Nodes with STAID (staidnode.aml)
- Adjusting Time of Travel (updatetot.aml)

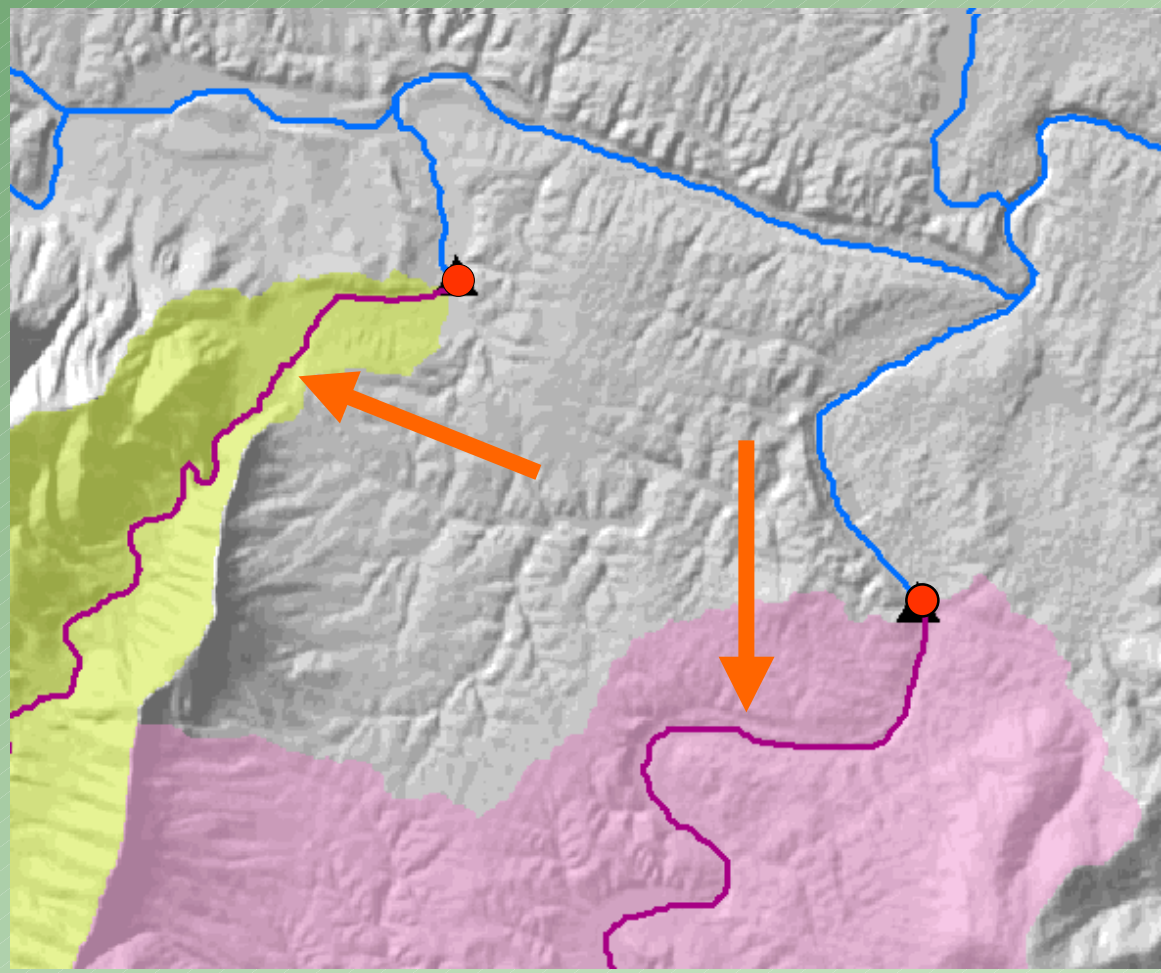
Adding Nodes at Monitoring Station Locations

- Associate reach
- Select and split
  - Re-number upstream ID
  - Attributes
    - STAID
    - TOT
- Now a Node Exists

  ❑Ensures watersheds are generated at station location

  ❑Attribute node with STAID

- Re-calculate TOT

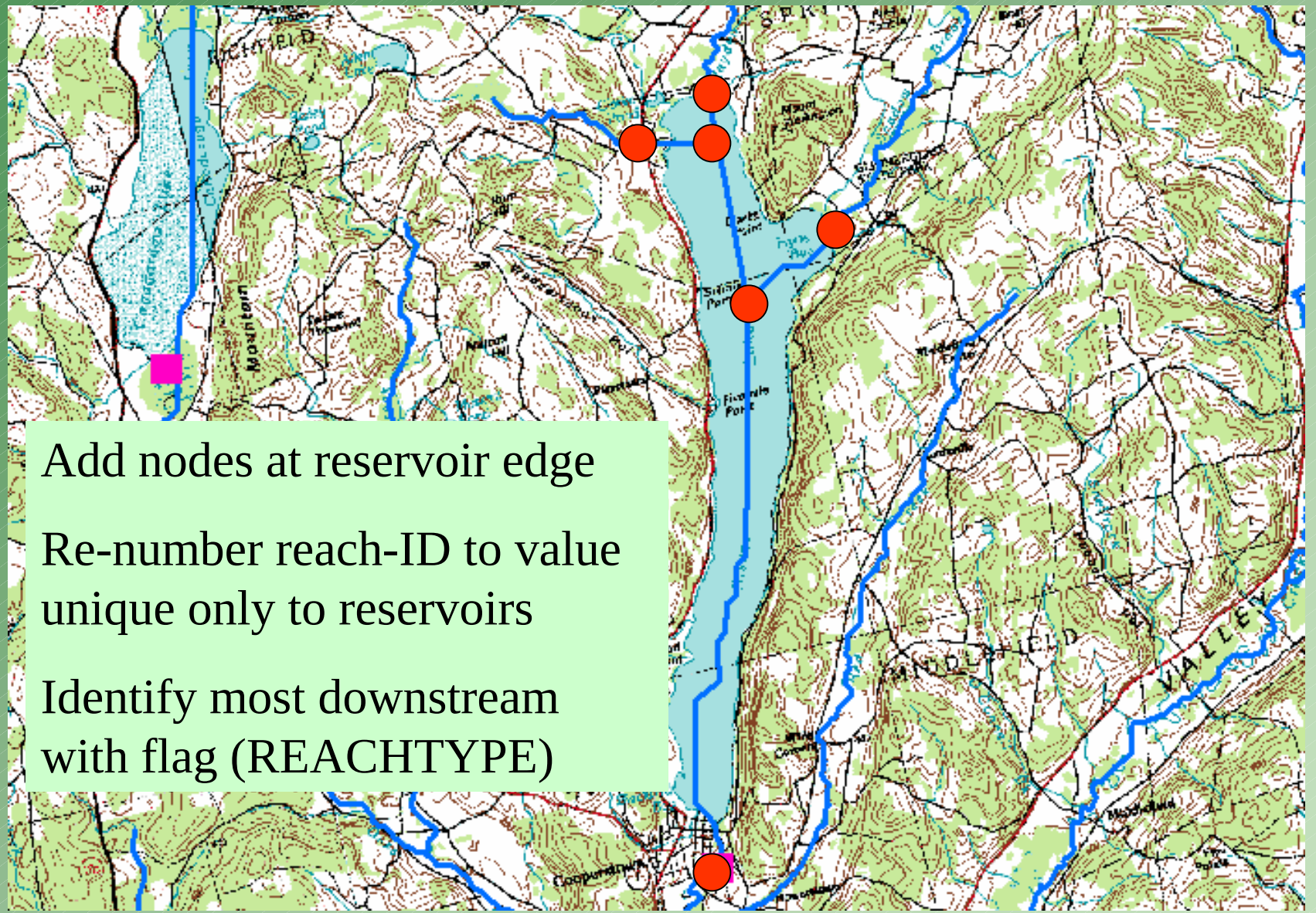


- Blue – Reach Network
- Black – Monitoring Station

Reservoir Association

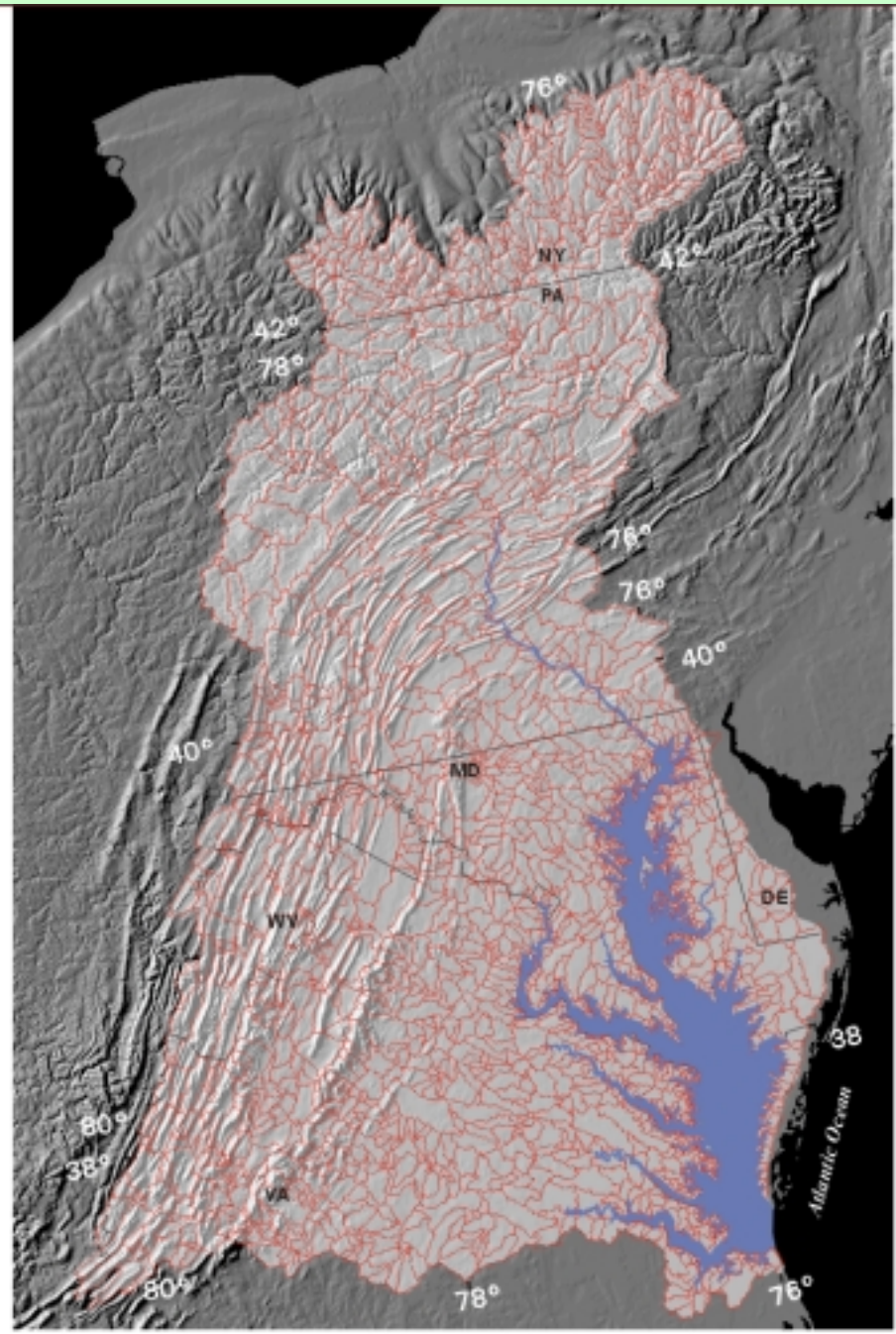
- Used ERF1 Attributes for 87 and 92 models
- Currently locate reservoir on reach
- Used surface area of reservoir for TOT calculation
- Used DRG and waterbody data sets to verify and/or digitize surface area of reservoir

Referenced Reservoir Information



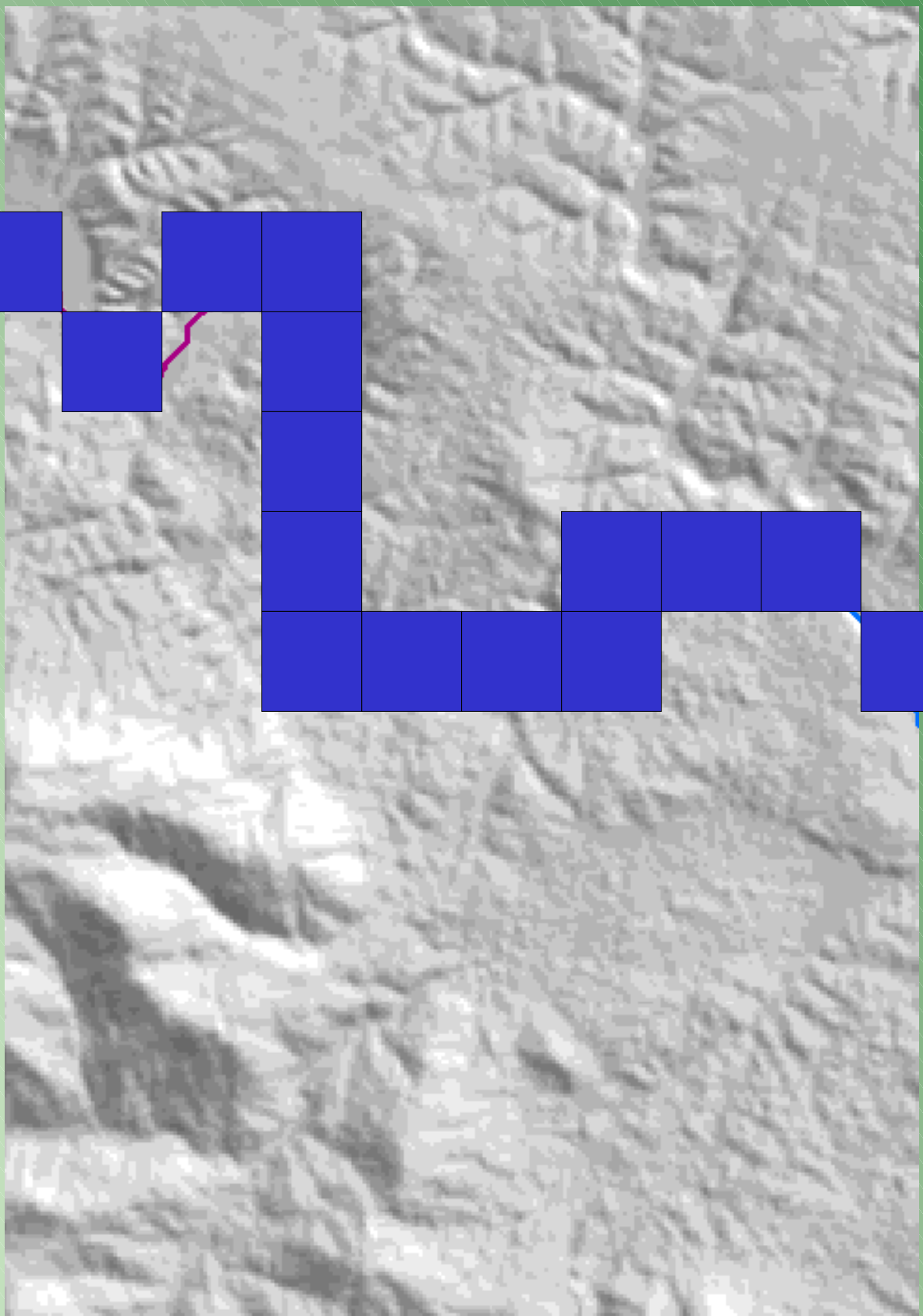
WATERSHED GENERATION

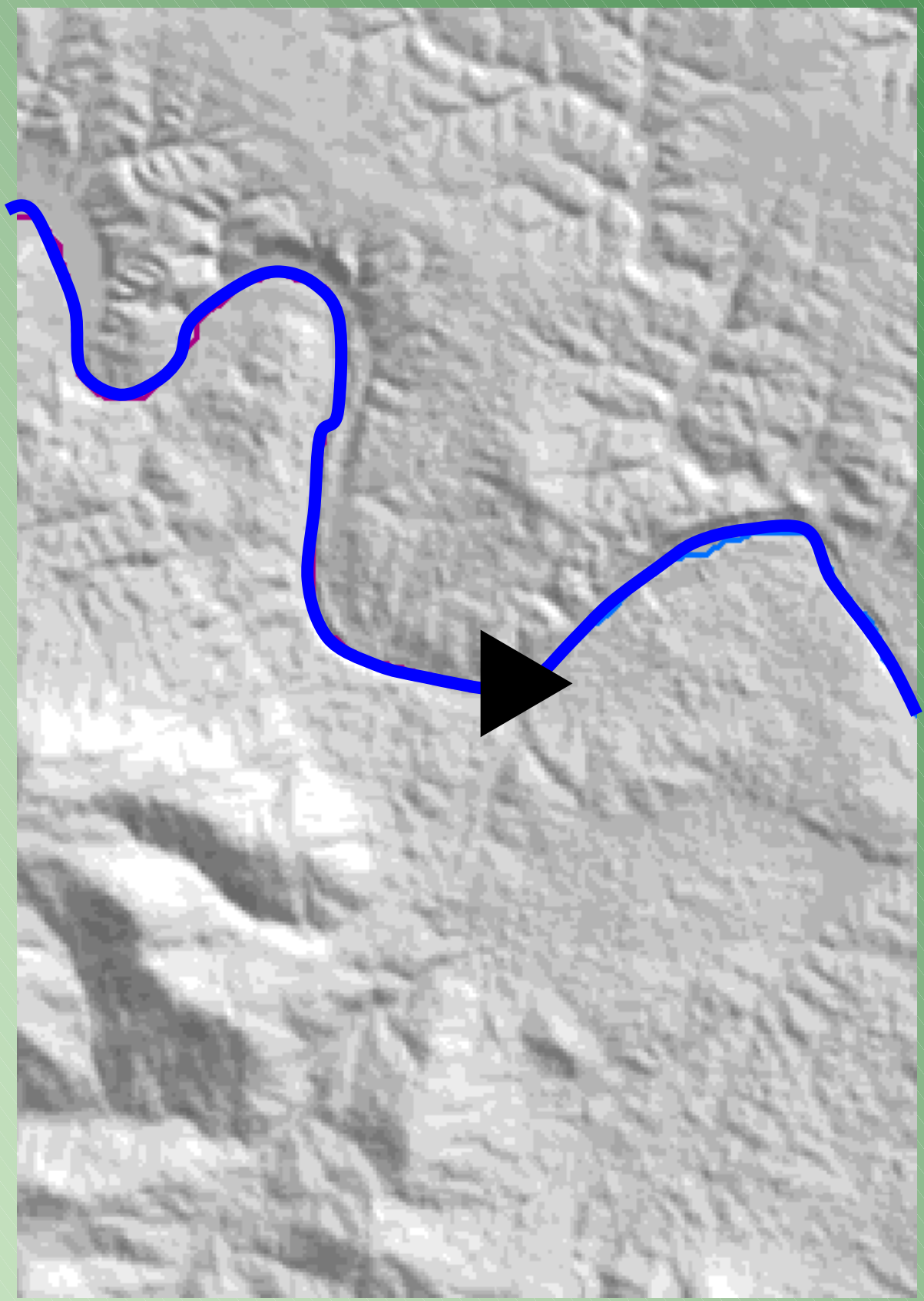
- ❑ Convert reach network back into 30m GRID (raster), using unique number as value (includes shoreline, reservoir, and calibration reaches)
- ❑ Use 30m Flow Direction to Generate Watersheds for each reach (~1400)
- ❑ Use all cells representing reach as pour points
- ❑Wsgrid = watershed(flowdir, reachgrid)

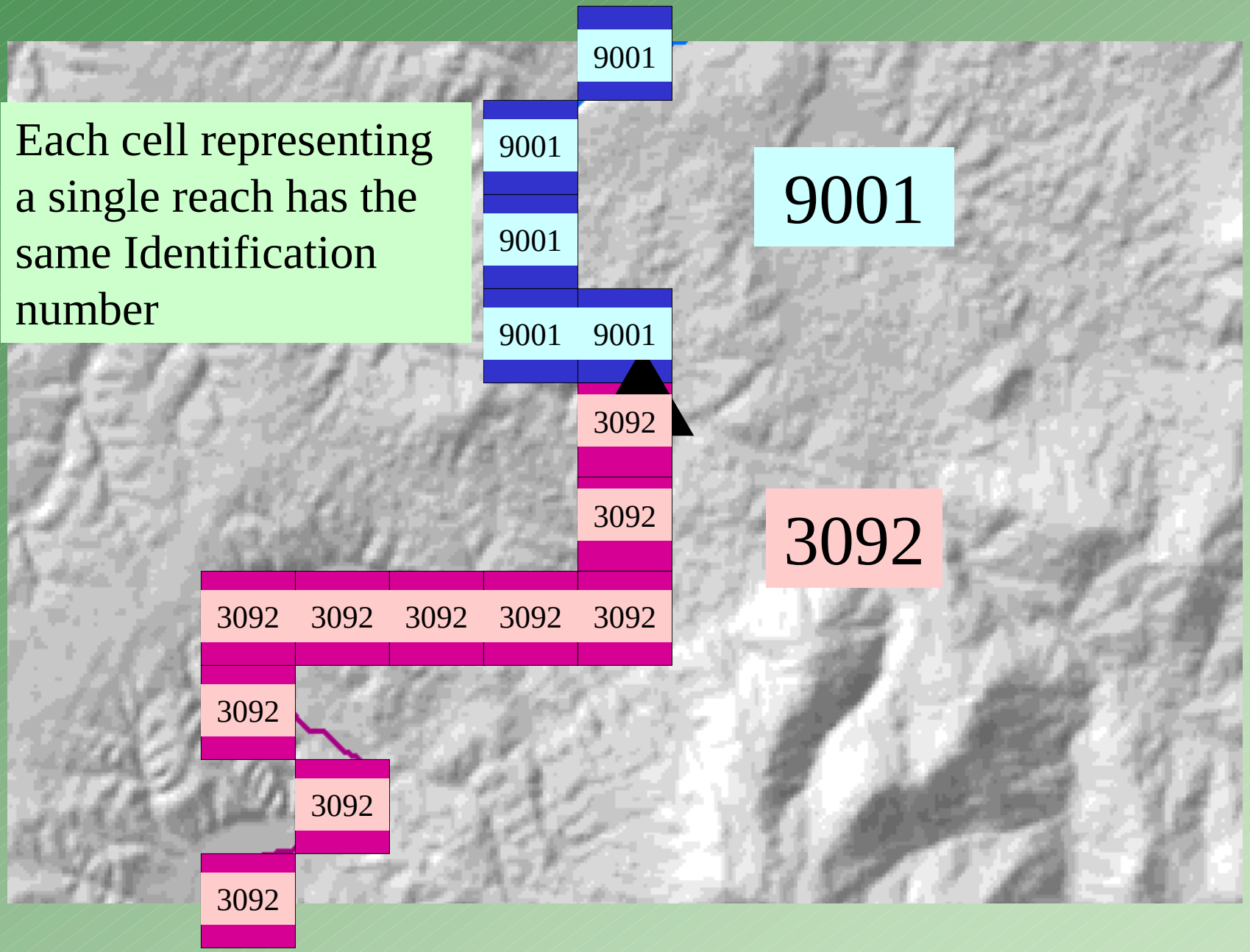


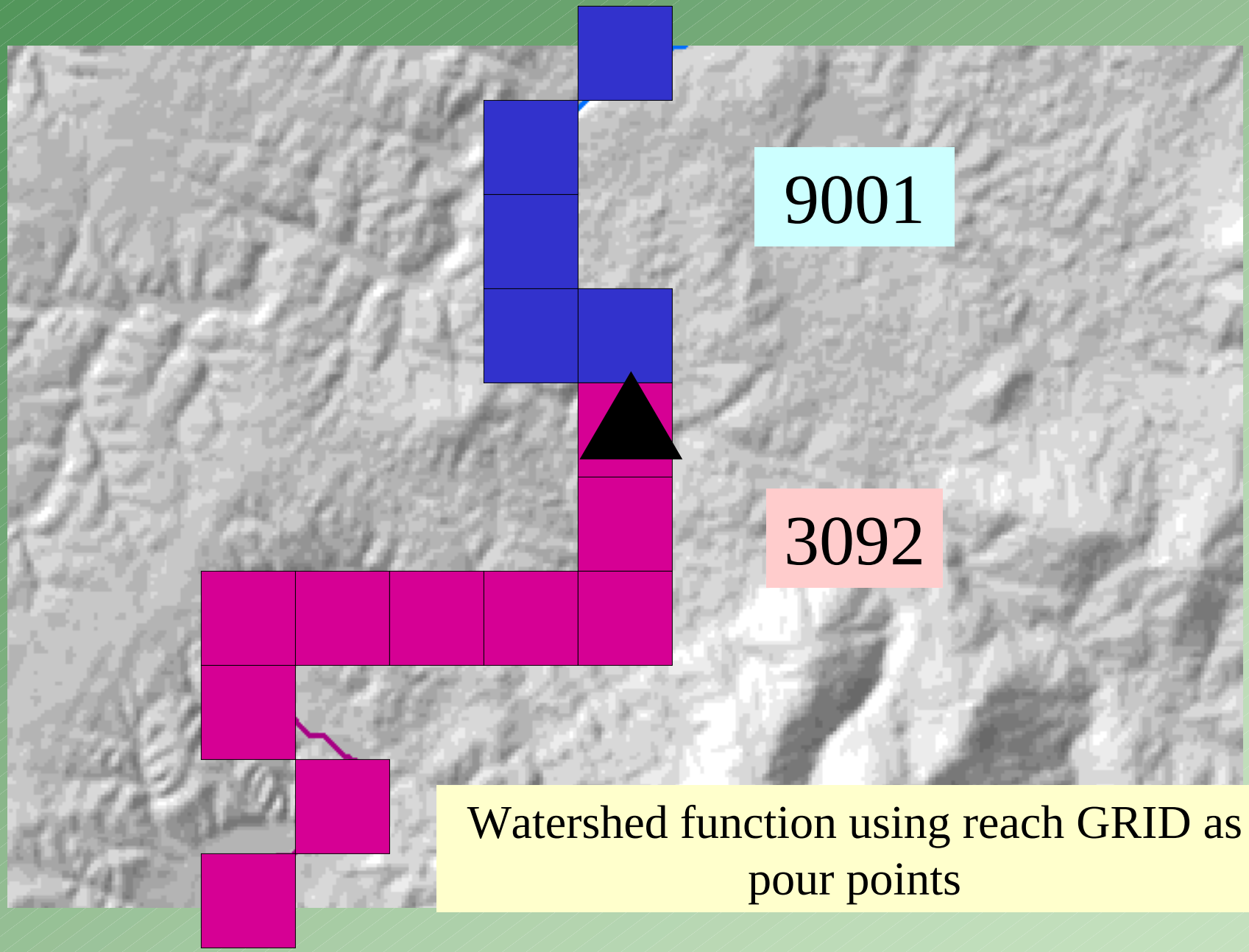
Advantages

- Does not rely on selecting most downstream pixel as pour point
- Allows for batch processing
- Maintains Reach-ID attribute
- Provides a watershed drainage area to estuaries that are non transport reaches

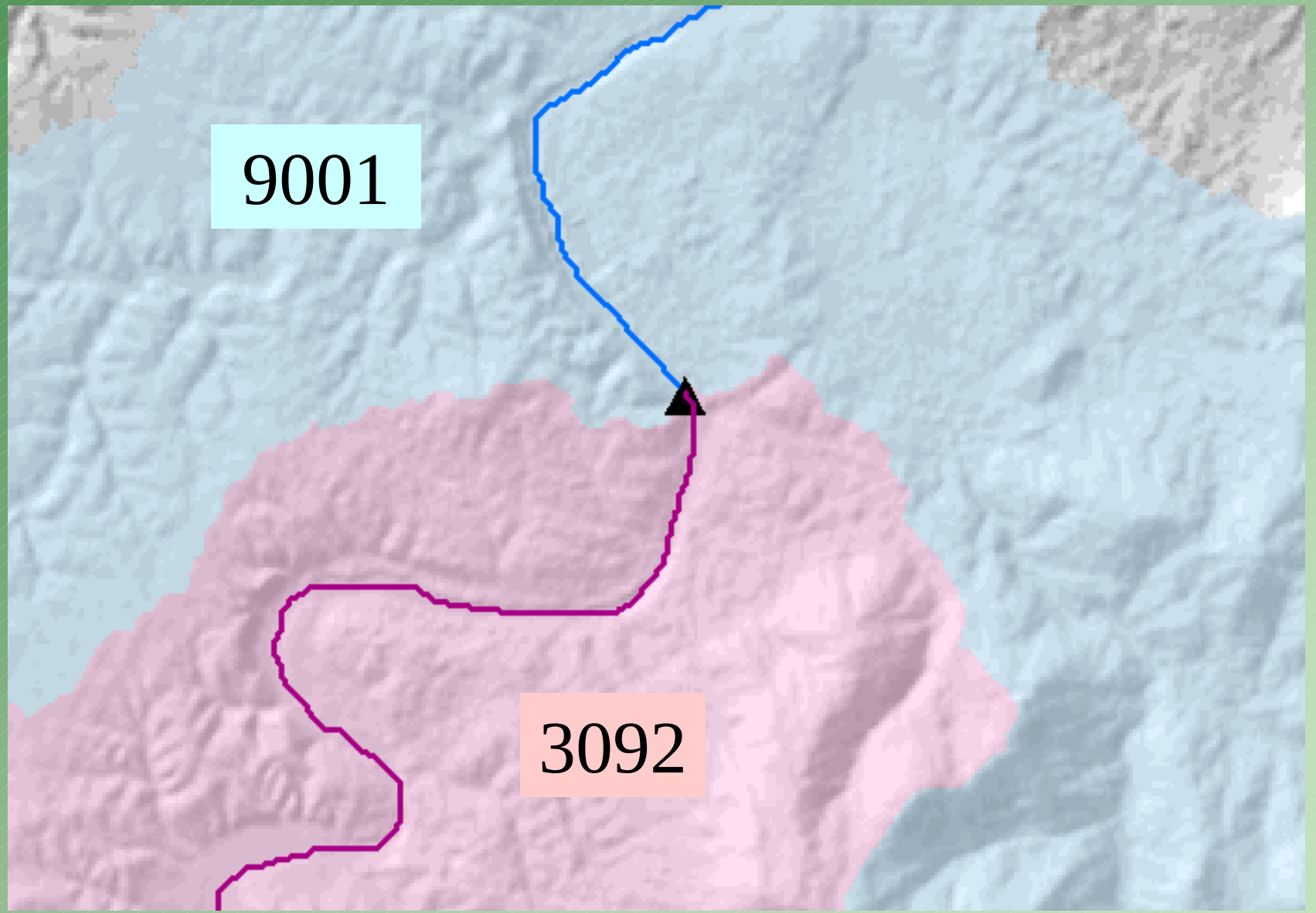





Each cell representing a single reach has the same Identification number
9001
9001
9001
9001
9001
9001
3092
3092
3092
3092
3092
3092
3092
3092
3092
3092
3092



Watershed function using reach GRID as pour points


9001
3092

Correcting watersheds

- Use CON (or select) function to generate GRID of reach (Stream GRID) that needs watershed. Include all reaches up and downstream of needed reach.
- SETNULL to calc all other values = NODATA. Keep CELLS with value of needed reach-id’s
- USE Stream GRID as pour points in watershed function.
- Use CON to select out needed watershed.
- Merge with Watershed GRID

Improving coastal areas from Version I, 1987

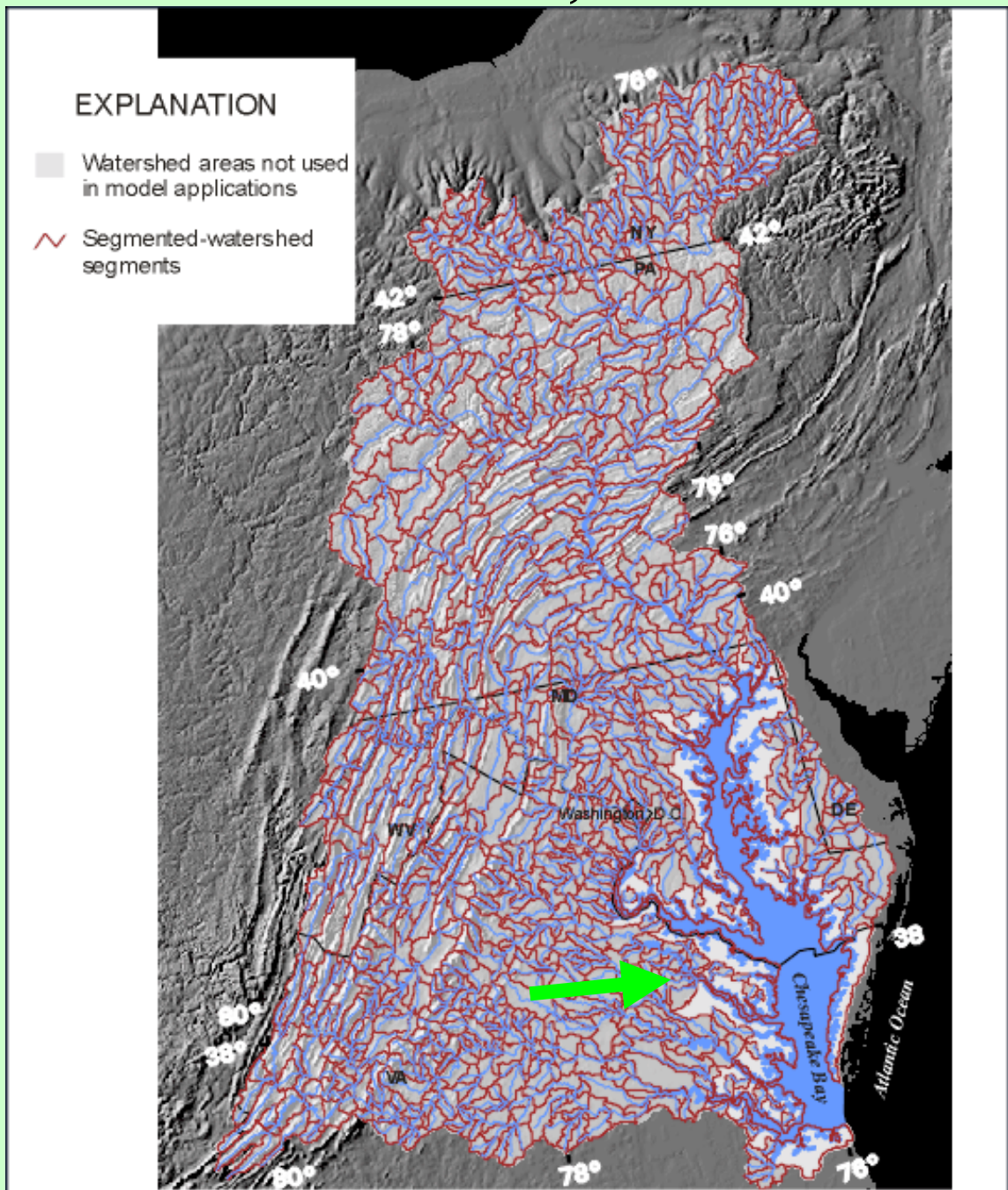
Convert RF1 network into 1k GRID, using unique reach ID number as value

Create Flow Direction

- 1k cell based on DEM
- Determines direction of flow across surface
- Use reach as pour points
- Generate Watersheds

No data in coastal areas

General watershed

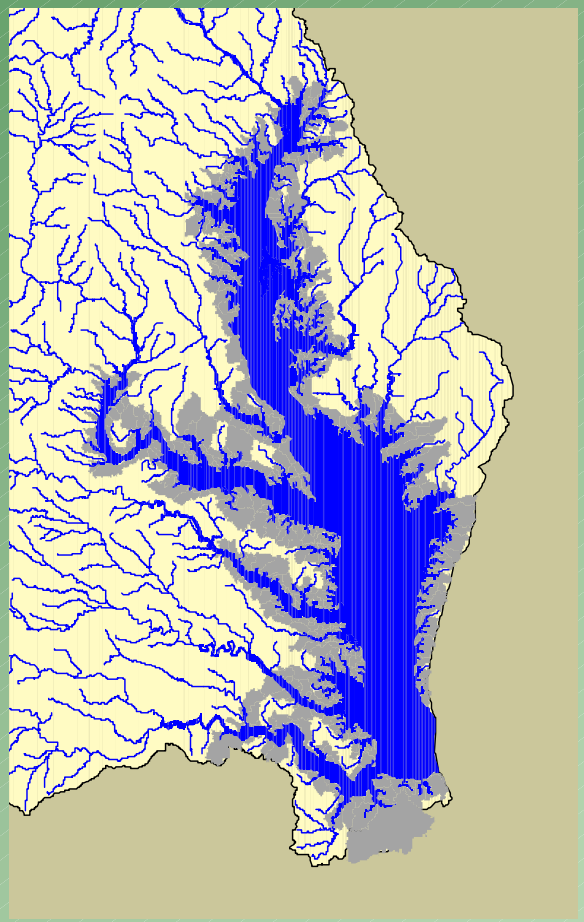


Improving Coastal Areas

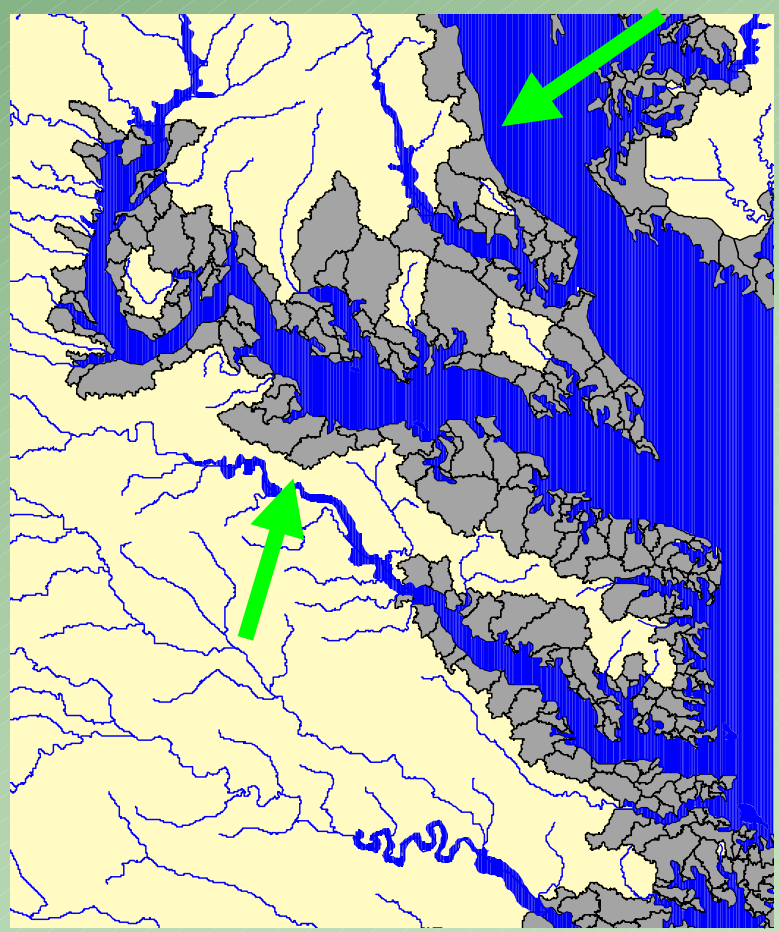
- Improve the prediction capability in coastal areas and estuary shorelines.
- Provide drainage to these areas.
- Stream length estimation.
- Regression for attributes.

Coastal Margin Network
Dividing Shoreline

- Split shoreline in arbitrary locations
- Shoreline treated as reach
- Attributed with Unique ID > 80,000



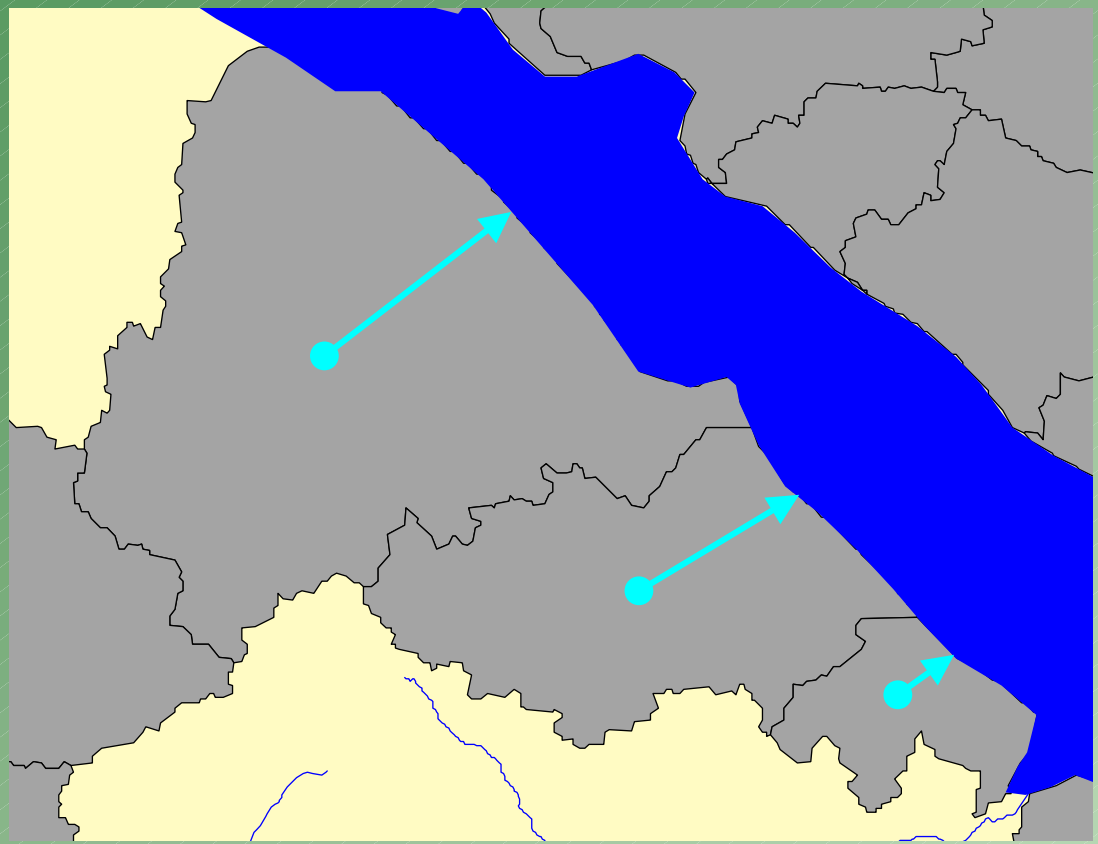
1987 Model



1992 Model

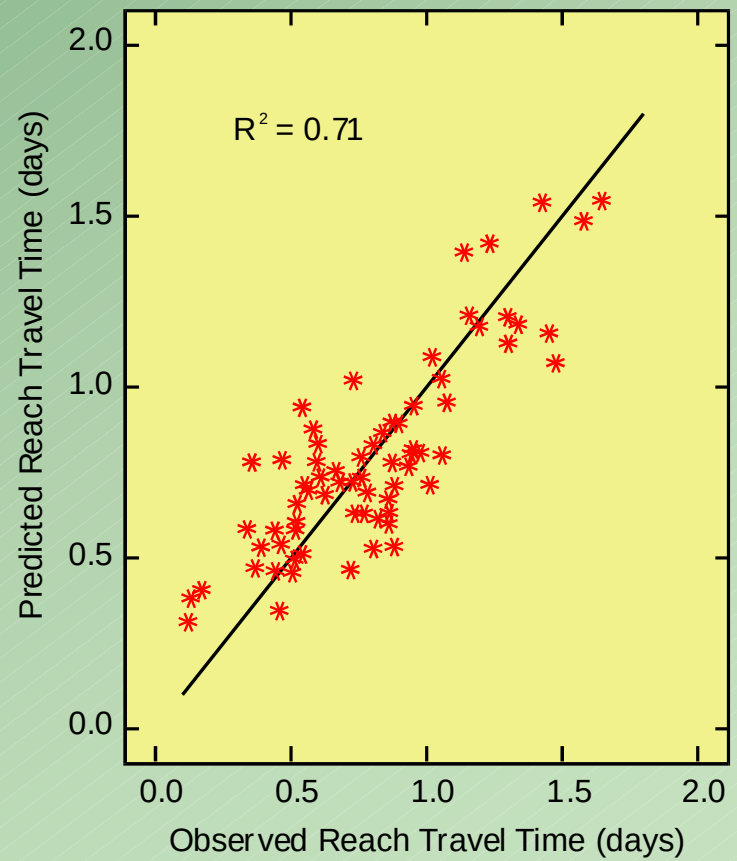
Travel Time Estimation in Coastal Areas

Watershed Centroid / Estuary Distance



Travel Time =

$$\beta_0 + \beta_1 \text{ Centroid} + \beta_2 \text{ Slope}$$

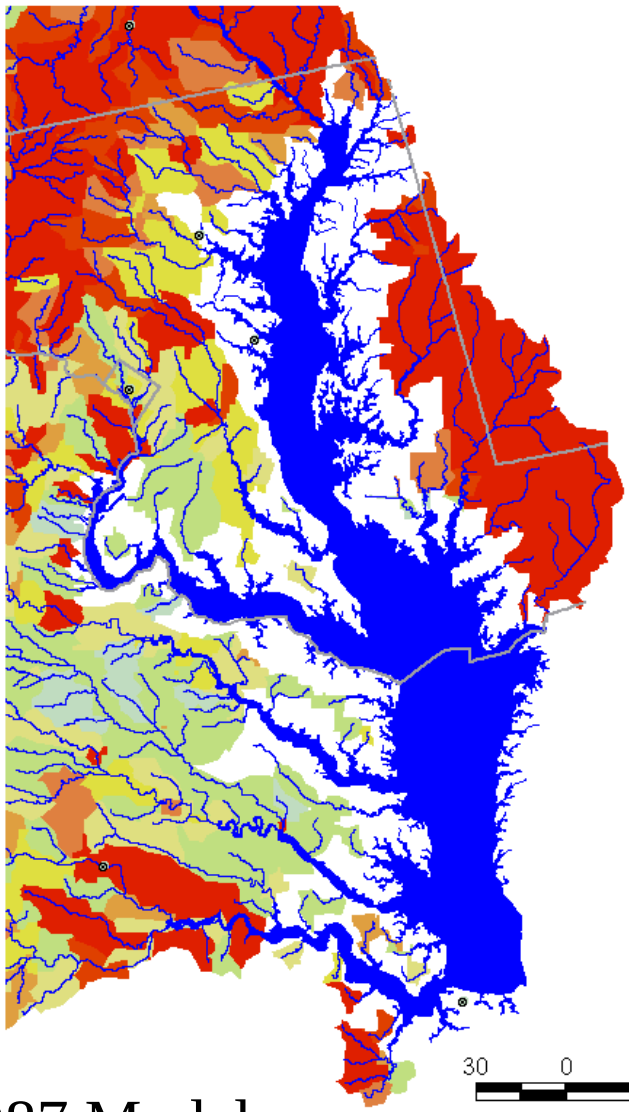


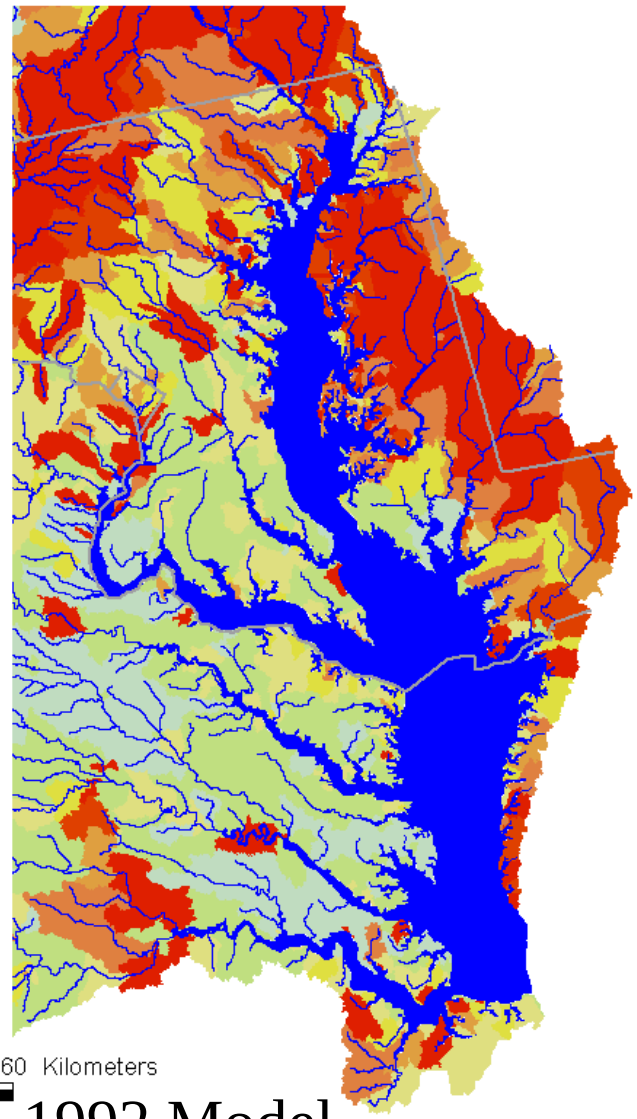
Process

- Zonalcentroid to create GRID of centroids of watershed REGION
- GRIDPOINT to create point coverage
- Delete non-estuary points (REACH-ID < 80000)
- Use NEAR to calculate distance to shorelines
- Verify NEAR command went to correct reach
- Use manual DISTANCE in AE to correct points associated to wrong shoreline.

Predictions in Coastal Areas

Improvement from 1987





30 0 30 60 Kilometers

1987 Model

1992 Model

Network Construction Summary

- DEM and reach data readily availability
- Stream Network Processing
  - Both Raster and Vector
- Used ERF1 Stream Characteristics
- 1 GIS person, 1 modeler
  - 3rd model, 6 months each
  - Mainly because limited network development
  - Tools have been created
  - http://md.water.usgs.gov/publications/ofr-01-251/index.htm
  - http://md.water.usgs.gov/publications/ofr-99-60/
  - http://md.water.usgs.gov/publications/wrir-99-4054/html/index.htm

SUMMARY

- RF1 is Building Block for Network
  - Stream Characteristics
  - Scale or Density
- 30m DEM used to Address Topological Issues
- Produced Improved Watersheds
- Improved Prediction Capability in Coastal Areas