Your fun and easy guide to
creating your very own water resources network and the tools to manipulate it

ArcGIS

Applying Arc Hydro and Utility Network Analyst

FOR

NITWITS

A Reference for All of Us
by
One of Us!

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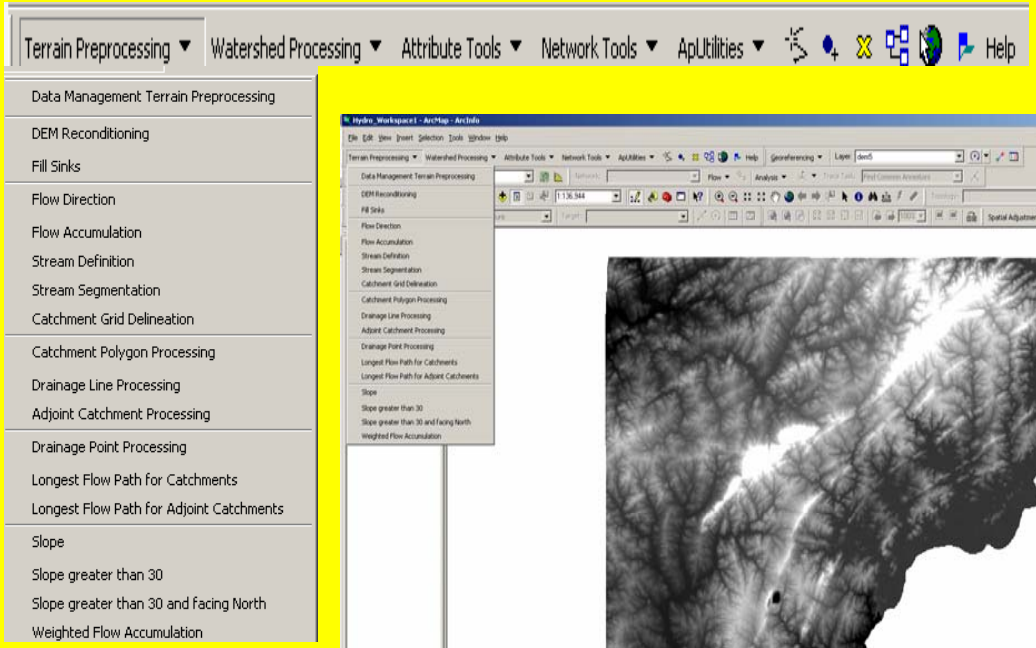
Objectives

- ✓ Present the differences between Arc Hydro and Utility Network Analyst, how they process data
- ✓ Examine the data types used, created and attributes necessary for analysis
- ✓ Present the nuances that plagued implementation
- ✓ Examine the possible uses of both applications independently and in concert
- ✓ Where you can go with the data you have created

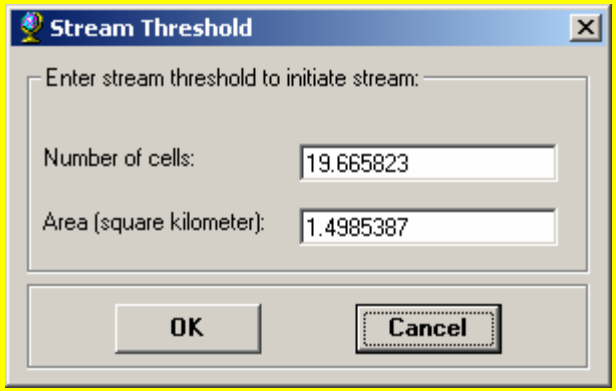
Arc Hydro: Getting Started

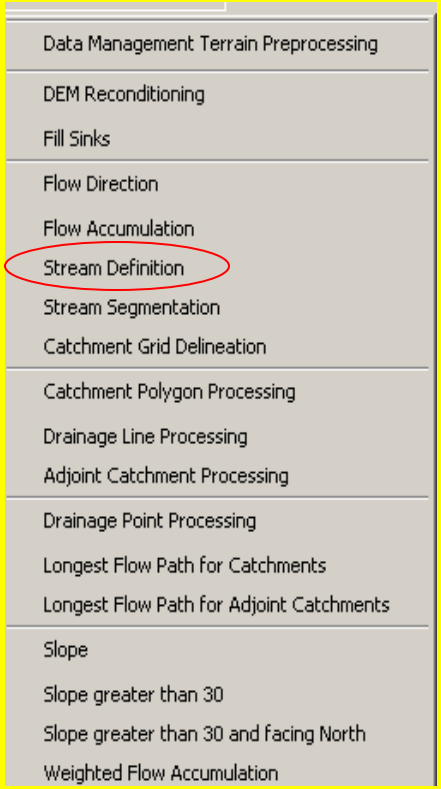
- ✓ Use the best resolution digital elevation model available, this example used a 5 foot resolution
- ✓ Tools in Terrain Processing, many are similar to those in Hydrology toolset in ArcToolbox with the exception of Stream Definition and Stream Segmentation
- ✓ All of the processes need to be applied to DEM in order, each process builds on the previous, crucial attributes are generated by several of the processes, skipping a step is detrimental
- ✓ Helpful to have a designated, robust computer for this task, many of the processes require hours to complete
- ✓ Arc Hydro uses elevation as the key attribute, connectivity is determined by water traveling from high to low



Process of Note: Stream Definition

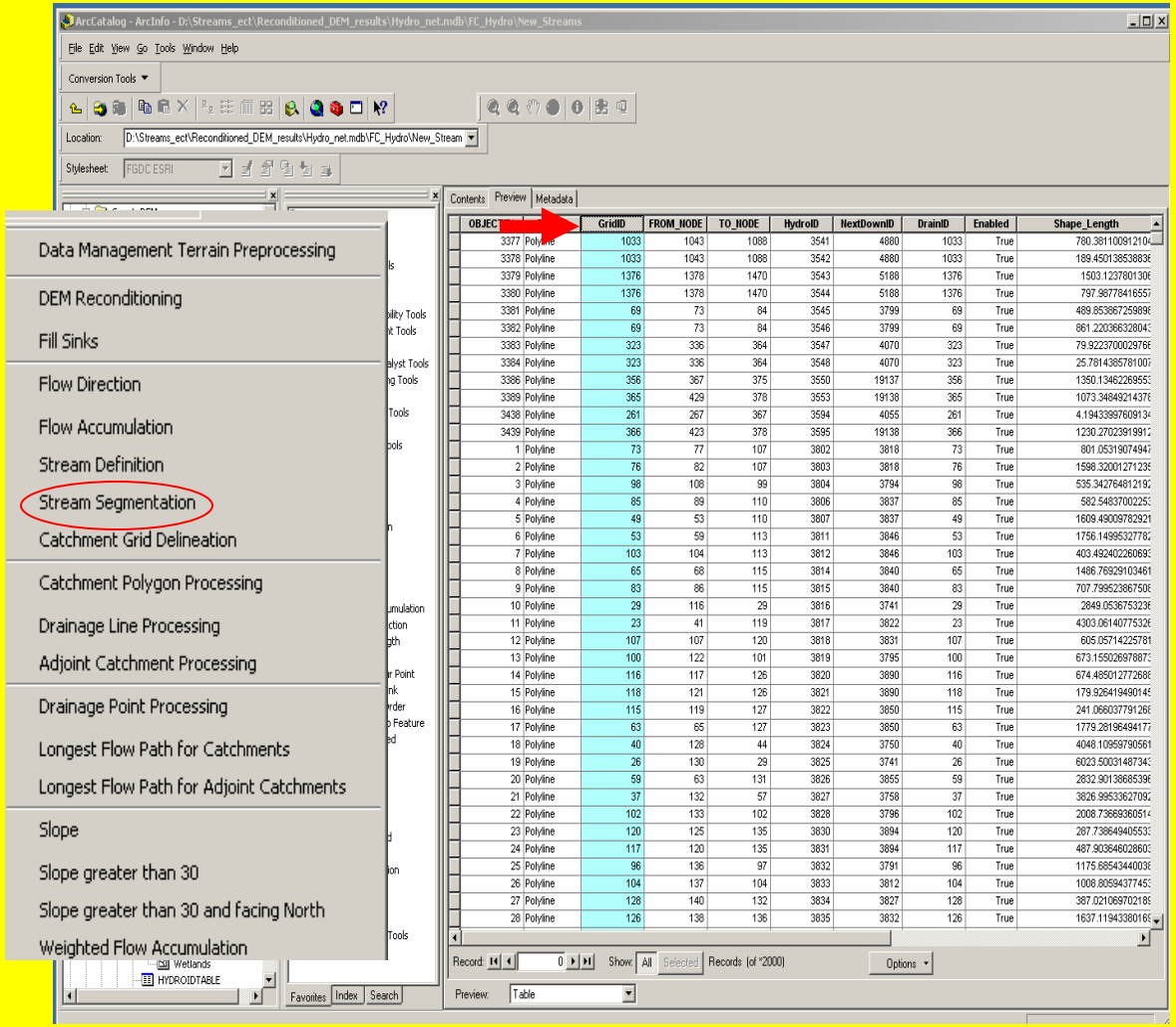
- ✓ Process defines the dendridic extent of output
- ✓ Default is 1% of flow accumulation of a given area, user has to decide the extent of the area of interest i.e., this example used a 16th of a percent (0.3375 km) which corresponds to 81.9 acre area
- ✓ Default value yields an output that when compared to USGS hydrography dataset is less dendridic, if you want to find potential or seasonal streams then you have to assign a smaller area of accumulation
- ✓ In this example, we ran this process several times to observe the difference in the outputs for different values for the area of accumulation





Process of Note: Stream Segmentation

- ✓ Process that generates GRID ID attribute
- ✓ Each cell of the DEM has a GRID ID and each segment of the generated stream output has the GRID ID that corresponds to the cell from which it originates
- ✓ Permits flow to be interpreted by the Arc Hydro tools
- ✓ If so much as one segment lacks a GRID ID attribute to tool fails to function
- ✓ Basis for to/from node generation
- ✓ This project floundered until this crucial detail was recognized



What You End Up With

- ✓ After each of the processes was performed on the DEM this was our raw output
- ✓ Next step was to correct data using aerial photography as ground truth
- ✓ Many of the generated segments were not consistent with actual river and stream locations as depicted in aerial photos
- ✓ Illustrates the difference between DEM depiction/representation of topography and actual ground truth
- ✓ Also illustrates the dynamic nature of hydrologic systems, rivers and stream often times change or modify their course of flow making ground truth measures vital

Editing Process

- ✓ Each of the segments needs to be moved control point (node) by control point (node)
- ✓ Segments that have large amounts of control points (nodes) can be shortened using the split tool on the editor toolbar
- ✓ This lengthy editing process is necessary, moving the segments maintains the integrity of the attributes associated with the segments
- ✓ A mistake I made was to delete segments and to digitize said same segments
- ✓ This was problematic because digitized segments did not have the necessary attributes for the Arc Hydro tools to function, i.e., GRID ID & Hydro ID

Edited Product

Incorporating Utility Network Analyst with Arc Hydro

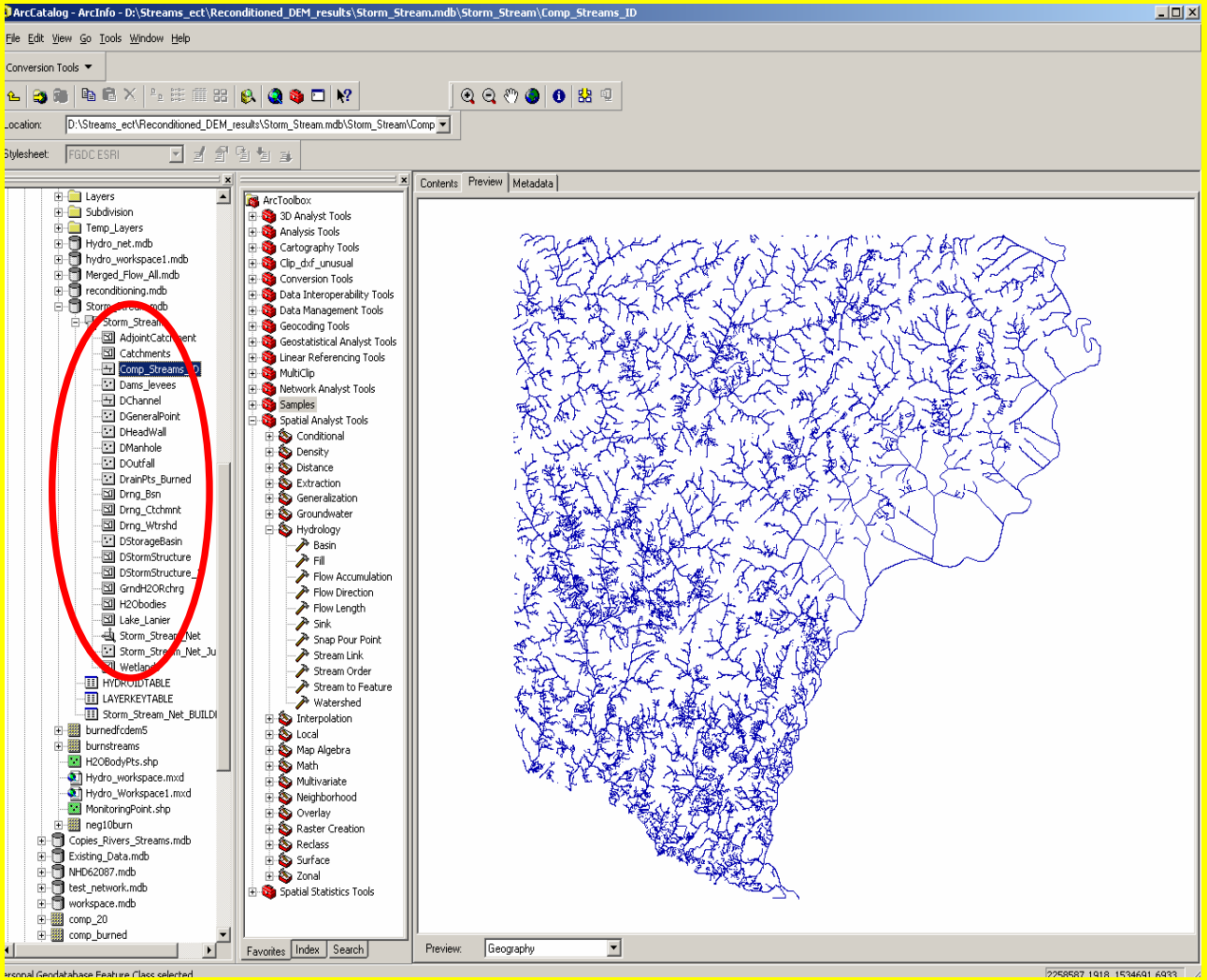
- ✓ At this point it is necessary to understand the difference between Arc Hydro and Utility Network Analyst
- ✓ Arc Hydro uses elevation at a given point or cell in juxtaposition to another point or cell to determine flow (applied physics, natural laws)
- ✓ Utility Network Analyst uses connectivity (proximity) of the segments as a means of determining flow (engineering as a means of moving water)
- ✓ Utility Network Analyst will function using the river and streams created using the Terrain Processing tools in Arc Hydro, but Arc Hydro tools only function with data created within the parameters of Arc Hydro, i.e., a digitized storm water system will not function using Arc Hydro
- ✓ Due to the differences in the way the tools analyze data it is necessary to “bridge the gap” between the two tools

Bridging the Gap

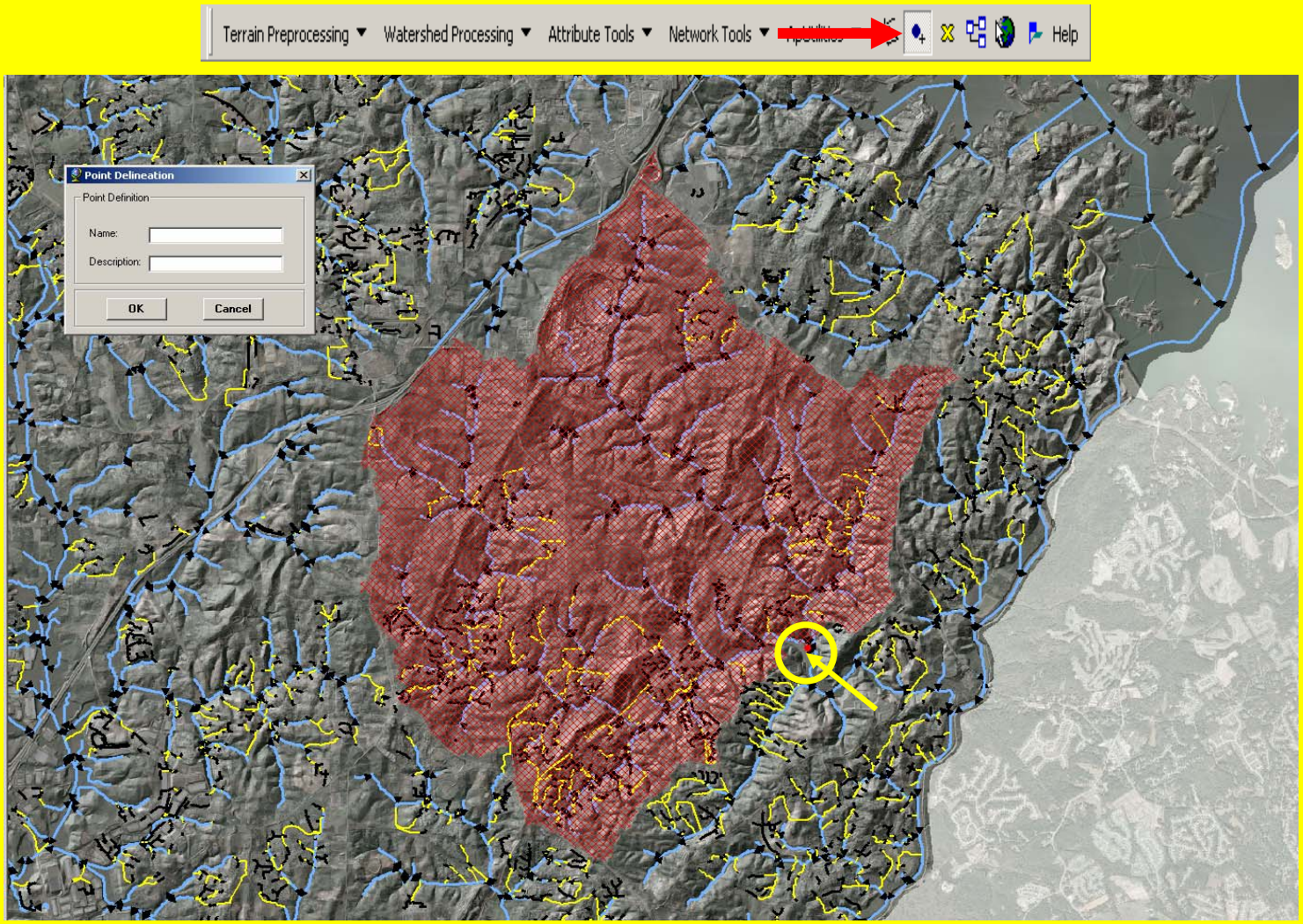
- ✓ For this project, the subject of connectivity was addressed as a question, “If water were to enter the storm water system, **where** and **how** might it come in contact with a fresh water source?”
- ✓ To address this it was necessary to look at each of the storm systems outfalls (discharge points) and the topography of the land between the outfall and the nearest source of fresh water
- ✓ Using the topography as a guide to how water could travel, lines of connection were digitized between the two data sources, the rivers and streams and the storm water system
- ✓ This method was used (there may be others) because it was a methodology that could be sold to engineers (very picky people) as being legitimate and possible

Putting All of the Pieces Together

- ✓ The rivers and stream feature class, the storm water feature class and the connective segments were then merged into a comprehensive feature class
- ✓ Then using ArcCatalog within a personal Geodatabase a geometric network was created incorporating all the desired feature classes
- ✓ There is also a network generation tool within Arc Hydro but this example opted to use the geometric network option
- ✓ Once a network has been created, the tools in both extensions can be applied to the data



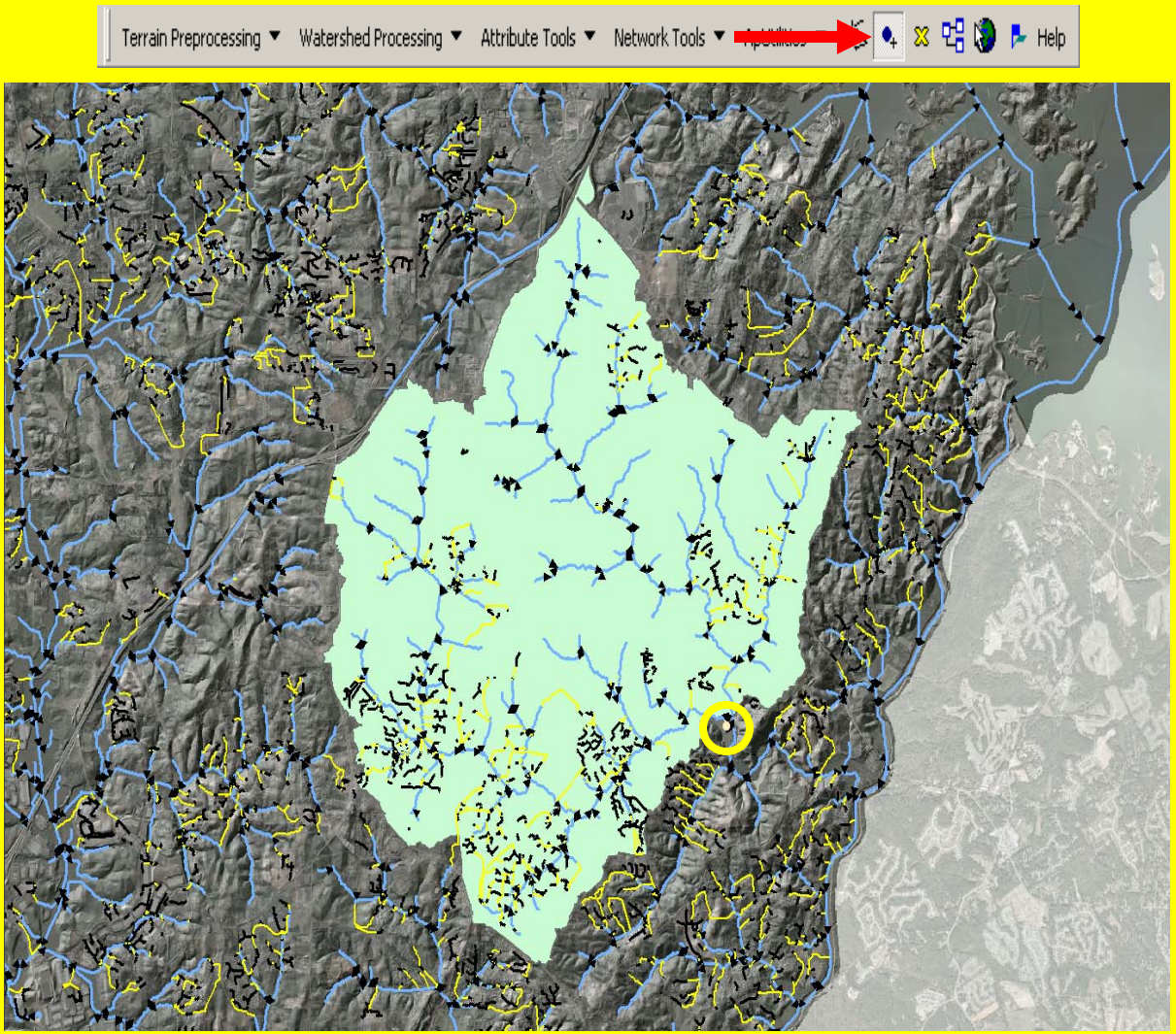
Arc Hydro: Point Delineation



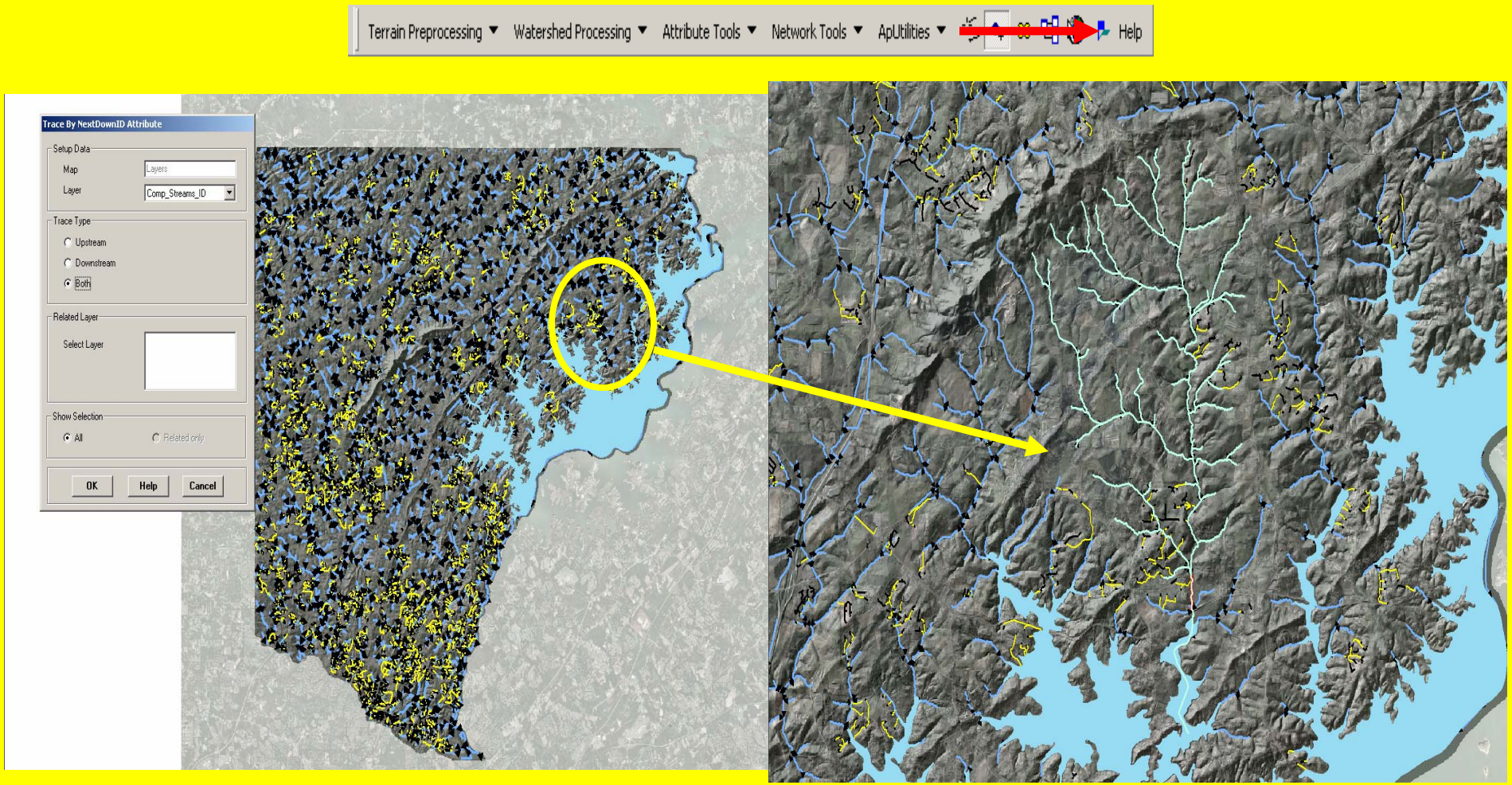
Red point within the yellow circle is the point of delineation, the red hatched region depicts area that drains to the point of interest

Point Delineation

- ✓ The region that supplies the point of delineation (watershed point) depicted in red cross hatches on previous slide is made into a stand alone feature class
- ✓ The point of interest is also made into a stand alone feature class, or watershed point
- ✓ Note, regardless of how the data was generated it is still encompassed within the area of delineation, the incorporation of both fresh and storm water sources
- ✓ Selections can now be performed and other associated operations to accomplish desired result and answer site specific questions

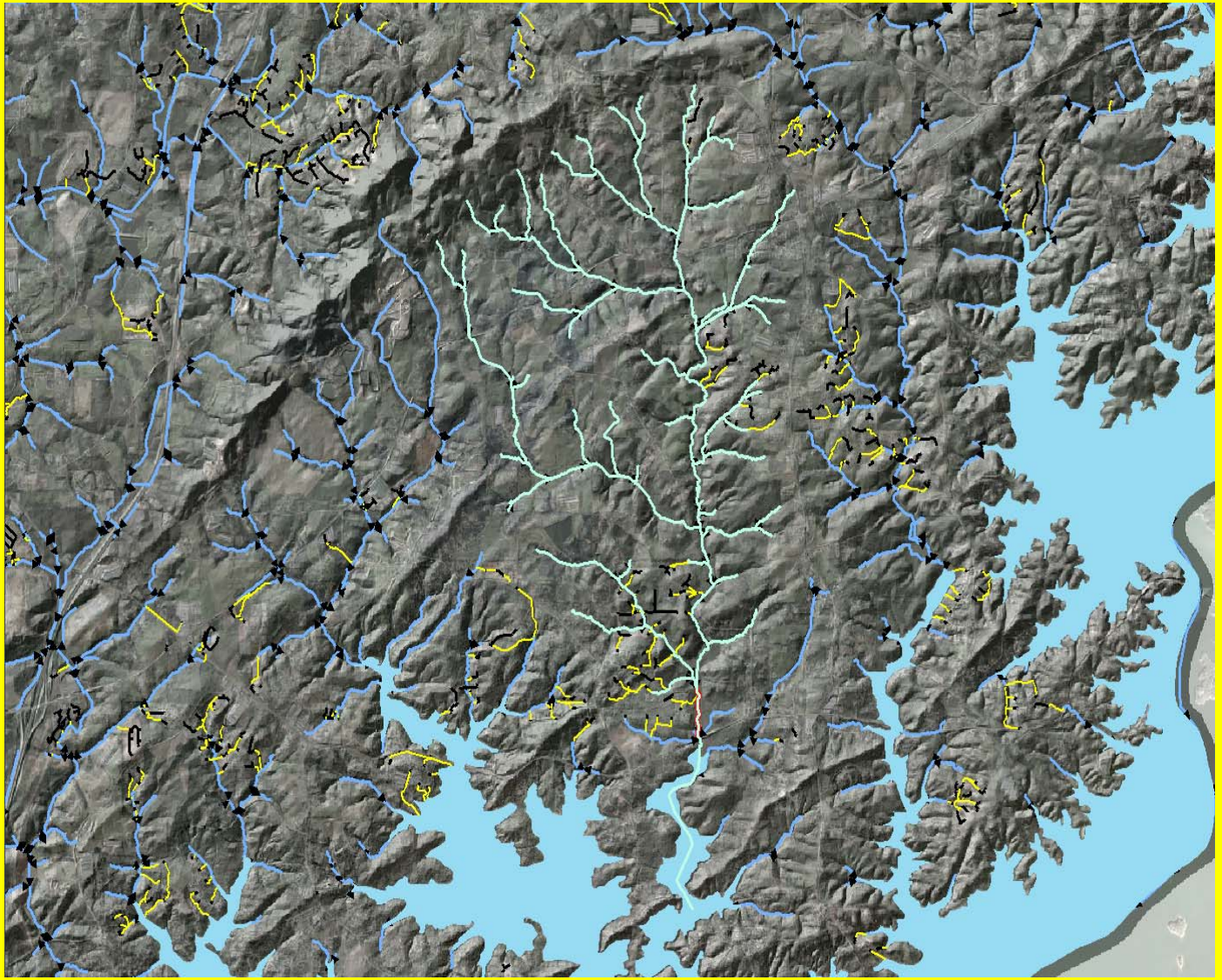


Arc Hydro: Trace by Next Down ID



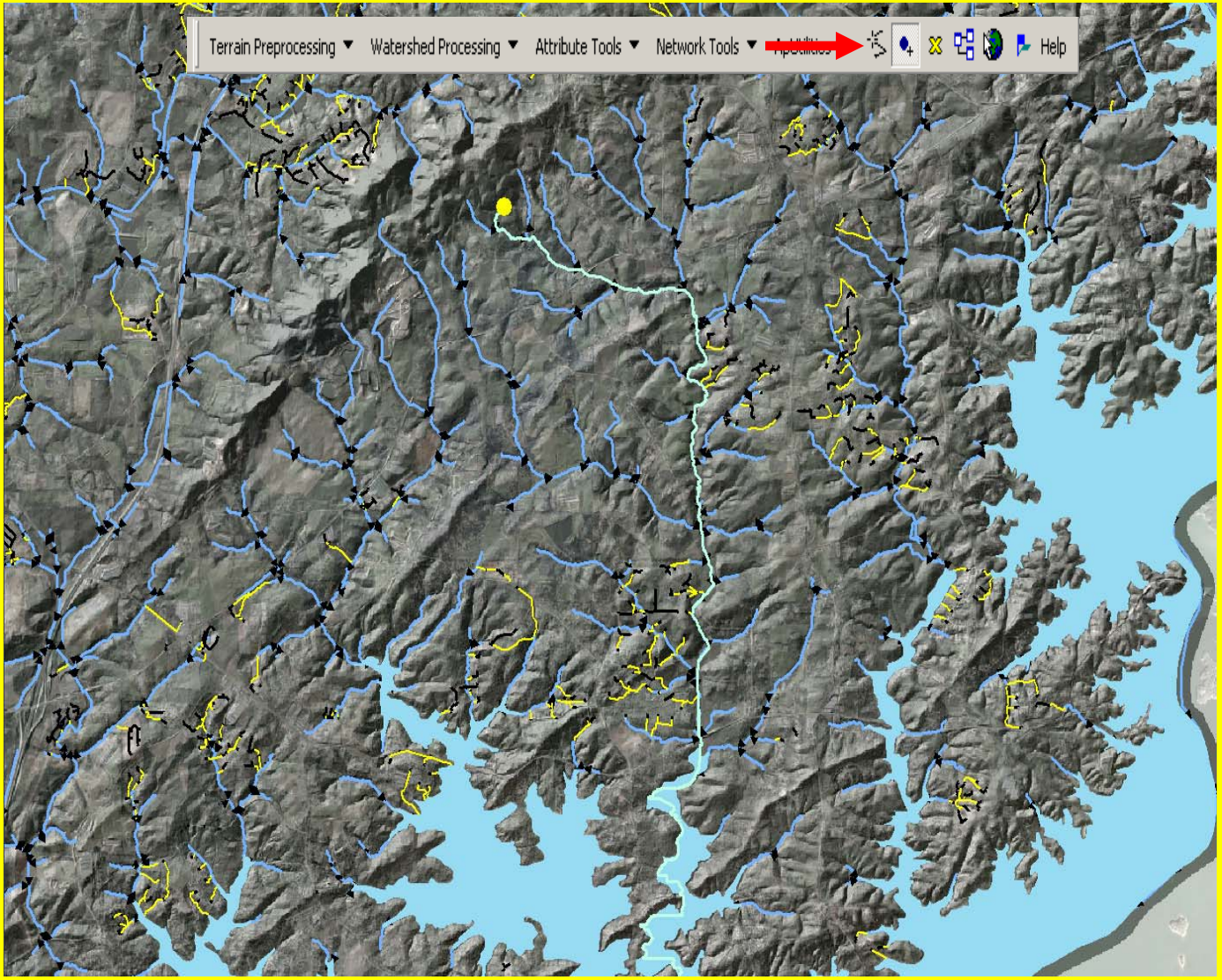
Trace by Next Down ID

- ✓ Only the rivers and streams were included in the up and down stream analysis, storm water portion of the data was excluded
- ✓ This is due to the connectivity attributes discussed earlier and the way the tools process the data in different ways
- ✓ Regardless of a rudimentary knowledge of hydrology, information about the whole network can be garnered from this analysis

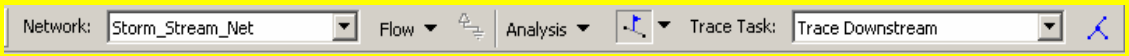


Arc Hydro: Flow Path Tracing

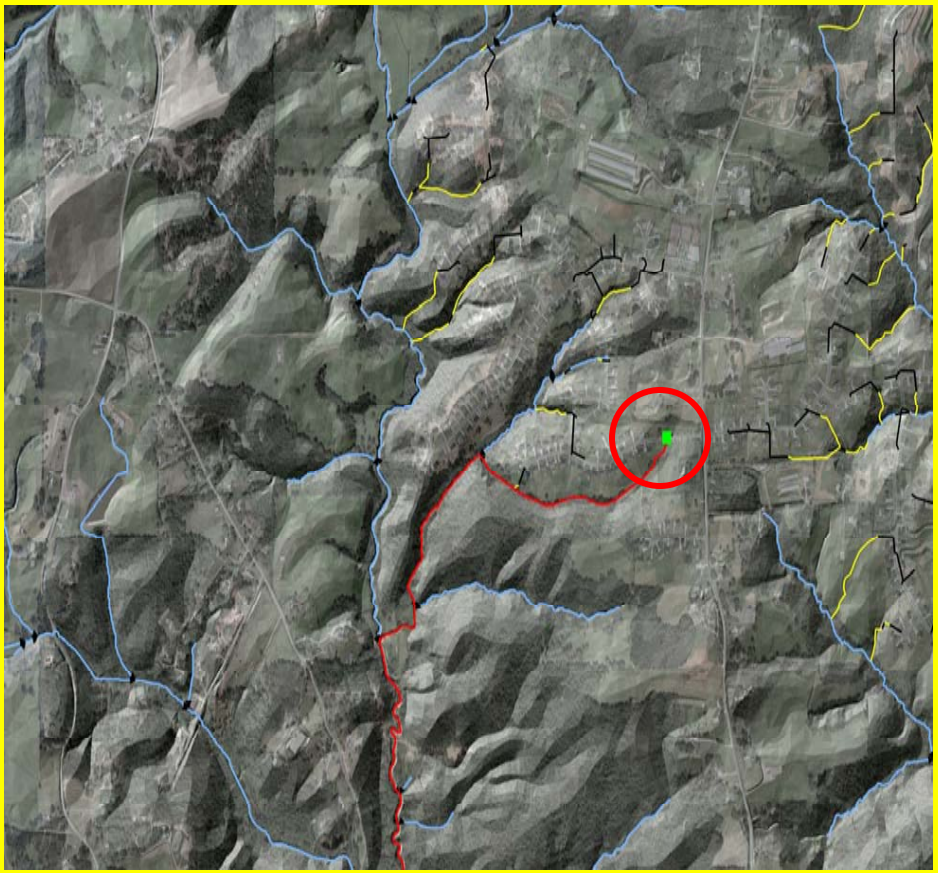
- ✓ Yellow dot is the genesis of flow
- ✓ Tool traces entire flow path
- ✓ Tool is repetitive in light of the other Arc Hydro tools
- ✓ Tool only traces flow of rivers and streams, not the storm water portion of the comprehensive network



Utility Network Analyst: Trace Downstream



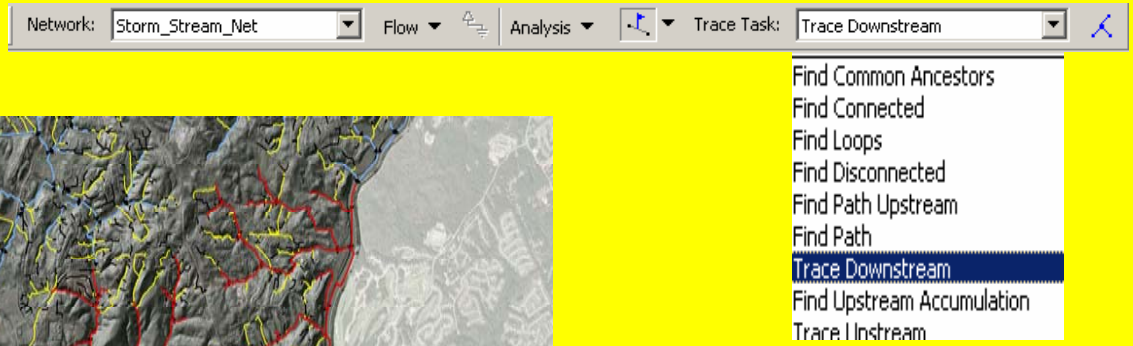
Green square depicts entry point of storm water system

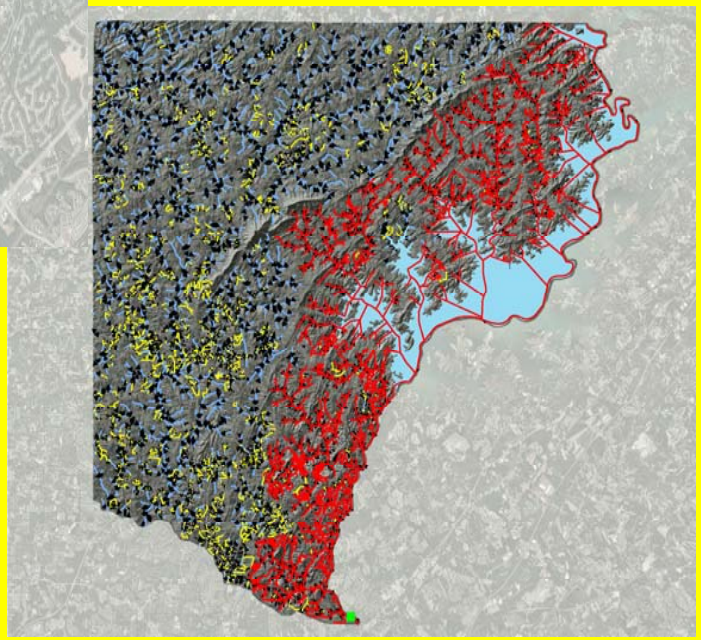


This tool works on the comprehensive network regardless of how it was generated

Utility Network Analyst

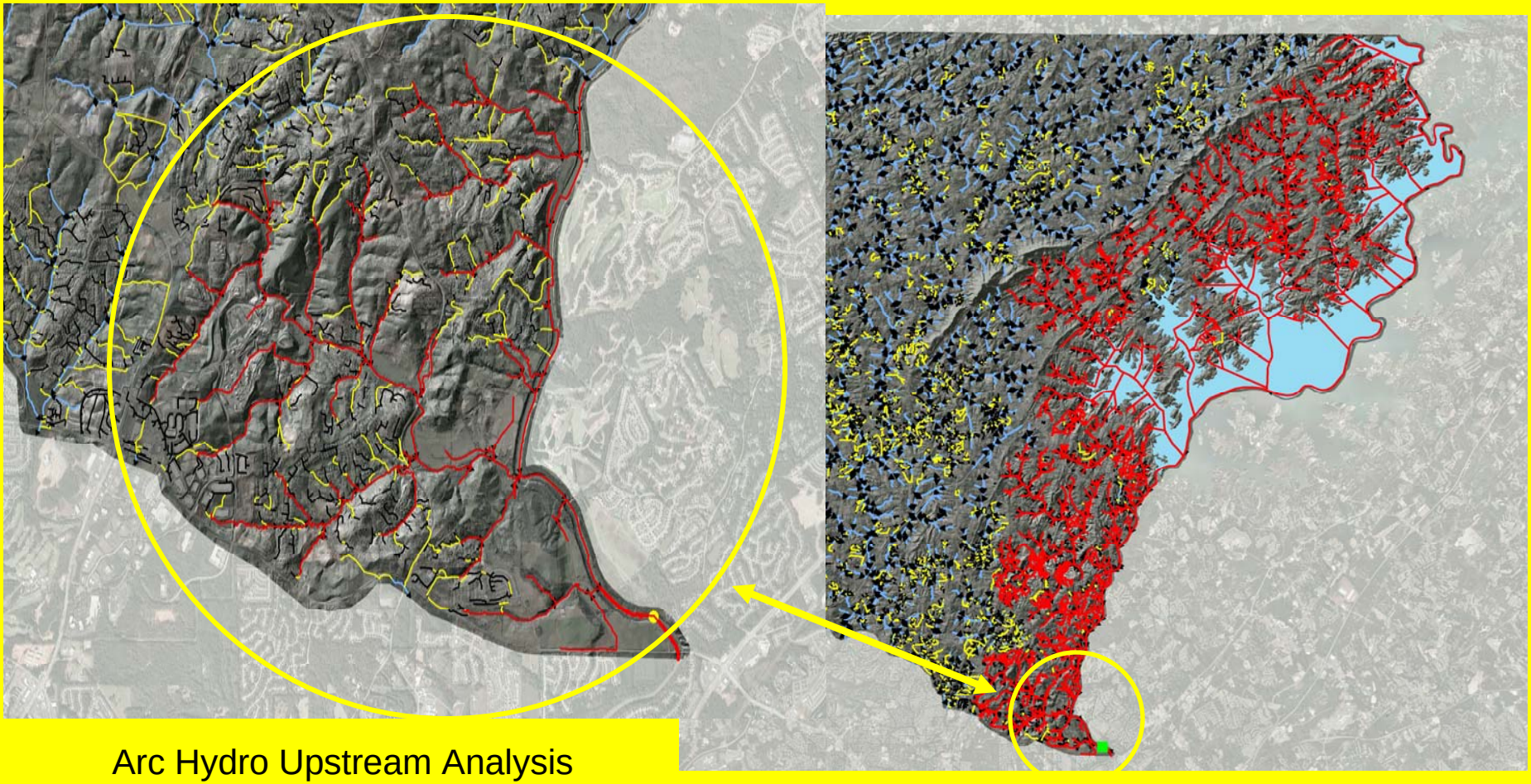
- ✓ Ability to perform many of the same analyses as Arc Hydro
- ✓ The main difference being that Arc Hydro has a limiting factor of topography and Utility Network Analyst looks only at connectivity independent of elevation
- ✓ This makes understanding your data, and the queries you wish to ascertain, crucial. Choosing to use the incorrect extension could yield erroneous results





Know the Difference between Extensions

Note the difference between the extensions and how this could be misleading



Arc Hydro Upstream Analysis

Utility Network Analyst Upstream Analysis

Applications For Your Snazzy New Hydrologic Network

- ✓Watershed delineation
- ✓Hazmat response
- ✓EMS applications, response
- ✓Homeland Security issues
- ✓Hydrologic Cycle modeling
- ✓Service area delineation
- ✓…and many more, just ponder the possibilities

What Next???

- ✓The next step for the Forsyth County Hydrologic network is linear referencing the rivers and streams (in progress)
- ✓This will allow for more complex analyses of not only where but how far and how long

Credit Where It's Due

1. ESRI. 2006. ArcGIS Help, Redlands, California.
2. Maidment, David. R. 2002. Arc Hydro, *GIS for Water Resources,* ESRI Press, Redlands, California. (These guys are sharp)
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4. Natalie representing ESRI in Atlanta, who asked me to present in the first place and John (the boss) for footing the bill allowing me to present today