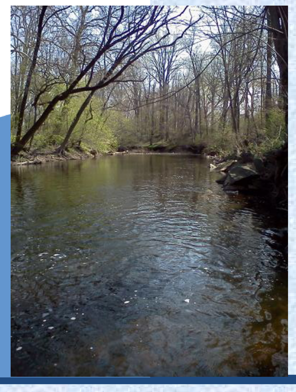
Sustainable UD **water**

WATERSHED ACTION TEAM FOR ECOLOGICAL RESTORATION



Hydrologic Forecast Modeling of Heterogeneous Land Uses in the Cool Run Watershed

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Quick Facts:

What is a Geographic Information System (GIS)?
GIS is a system composed of hardware, software, and data. GIS is used to capture, store, integrate, manipulate, analyze, and display data related to **location** on the Earth's surface. It incorporates **geographical features** with **tabular data** in order to map, forecast, analyze and come up with best management practices to **solve real-world problems**.

What is ArcMap?
ArcMap is the comprehensive map authorizing and **data analysis** component of ArcGIS Desktop. It is an application used for querying, analyzing, editing, and mapping data. In ArcMap, you **compile, edit, and create** data. It is also the application used for **cartography**.

What is Hydrologic Modeling?
Hydrologic models are simplified, conceptual representations of a part of the cycle of water in a particular watershed. They are primarily used for hydrologic prediction and for understanding hydrologic processes.

What is a watershed?
An area of land where all of the water that is under it or drains off of it, goes to the same place.

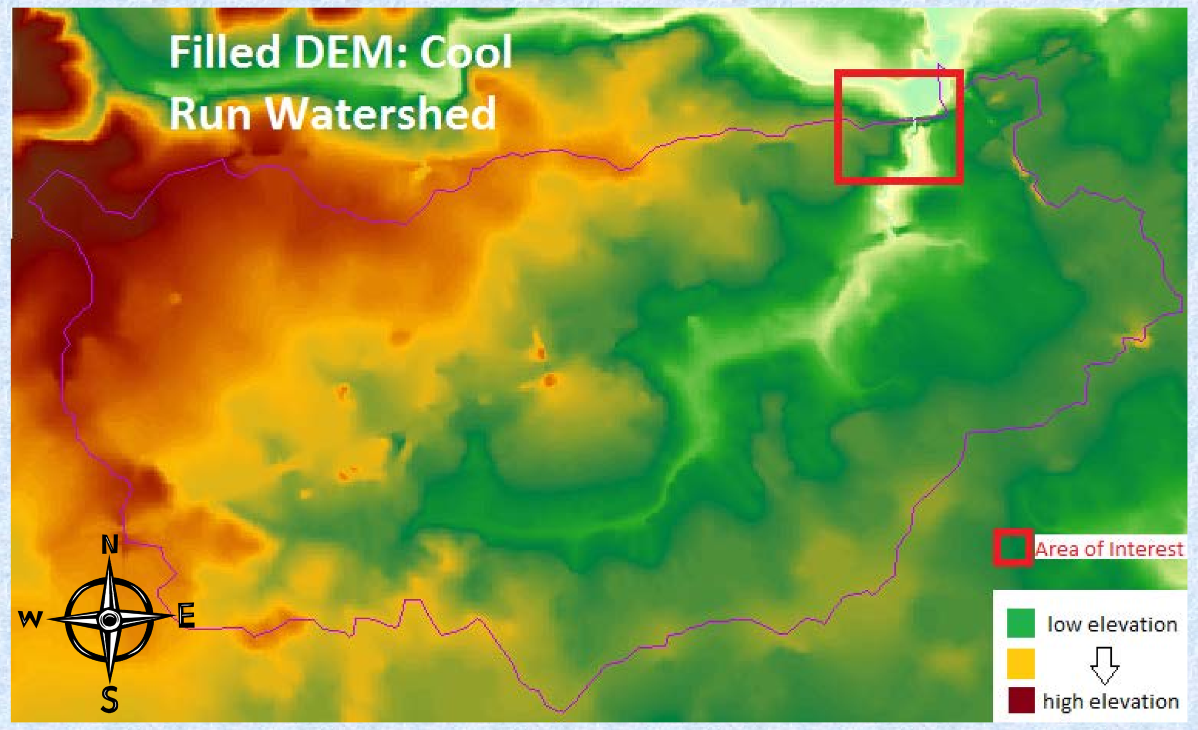
Project Goals

The goals of this project were to use Geographic Information System technology to:

1) To develop a computationally efficient hydrologic model of the Cool Run Watershed based on existing GIS layers and data
2) To correct local data anomalies to make the Digital Elevation Model (DEM) support true runoff patterns in the Cool Run Watershed
3) To compile all important and relevant GIS data for use by others in forecast modeling and developing best management practices to protect the Cool Run Watershed
4) To model runoff impacts from each different land use within the Cool Run Watershed

Methods: Used ArcMap Spatial Analyst Tools To…

1) Import a 10x10 DEM of the study area



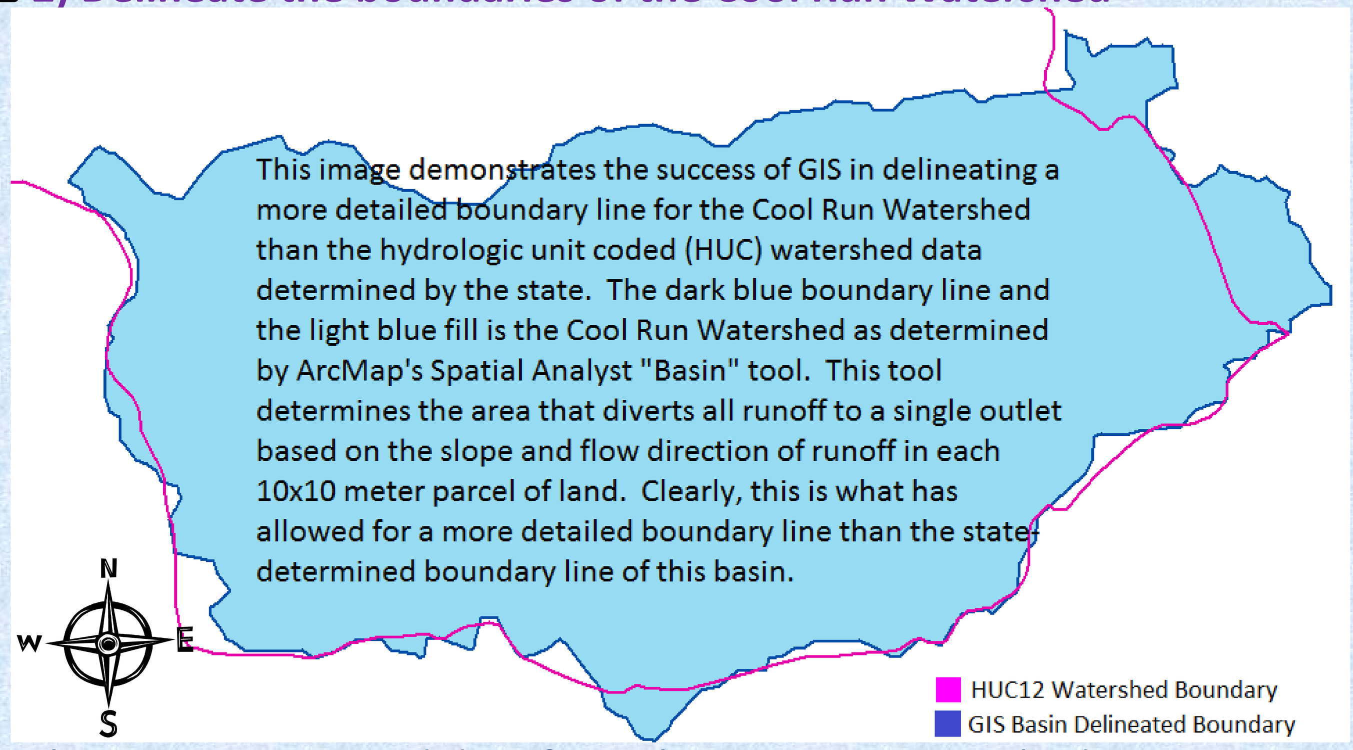
A "filled" DEM is one with all of the local depressions in the land filled in. In this image, you can clearly see the stream channel (white).

It was necessary to correct the DEM at the mouth of the Cool Run Tributary (the red square on the DEM). Because a digital elevation model takes into account the elevation of 10x10 meter squares of land, it originally redirected our runoff output flow to the upper right corner, northeast of the actual mouth of the Cool Run. The data at that point was not representing the land itself, but instead was representing a manmade structure (building) with a higher elevation than that of the stream channel. After investigating the area, we discovered the reason for the difference and were able to correct it on our DEM. To the right is a picture of Dr. Mackenzie investigating the mouth of the Cool Run.

GIS Data Complied for the Cool Run Watershed:
Land Use, Runoff Percentages, Watershed Boundaries, Corrected Digital Elevation Model, Flow Direction, Flow Accumulation, Roads, Railways, Soils , Impervious Surfaces, Streams, Delaware Aerial Data

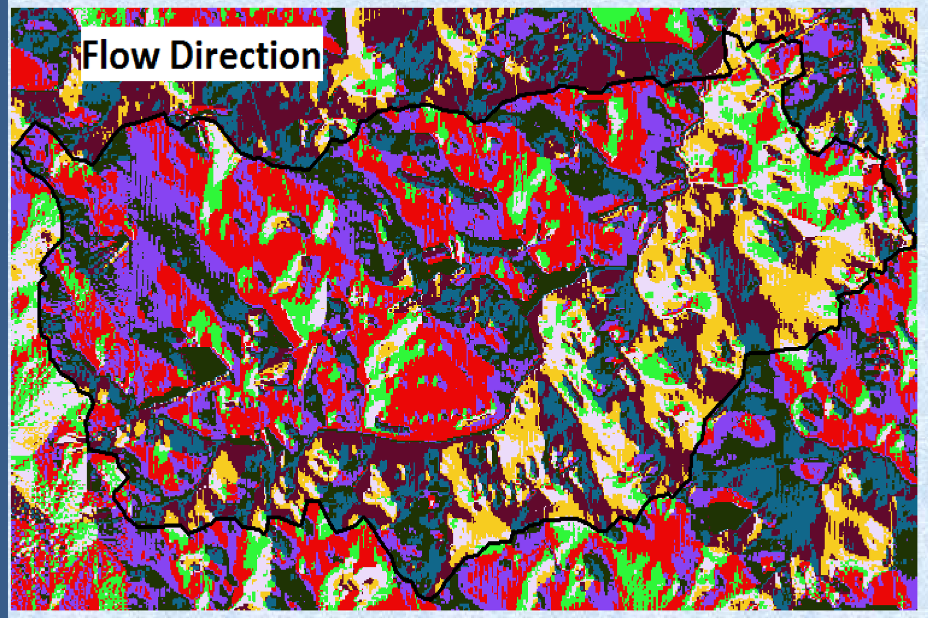
Special thanks to **Professor John Mackenzie** without whom I would have not have accomplished or learned nearly as much as I have throughout the course of this project. Additional thanks to all the members of the UD Water Team: my fellow interns Melanie Allen, Dakota Laidman, Rina Binder-Macleod, and Melanie Allen as well as Tom Sims (Delaware Water Resources Center and Project Coordinator), Jerry Kauffman (UD Water Resources Agency and Project Coordinator), Carmine Balascio (UD Department of Bioresources Engineering), Stacey Chirnside (UD Department of Bioresources Engineering), Martha Narvaez (UD Water Resources Agency), Kelley Dinsmore (City of Newark), Andrew Homsey (UD Water Resources Agency), Dan Leathers (UD Department of Geography / Delaware Environmental Observatory System), Mike Loftus (UD Facilities), Jenny McDermott (UD College of Agriculture and Natural Resources), Tom McKenna (Delaware Geological Survey), Jennifer Pyle (UD Environmental Health and Safety), Mike Sistek (City of Newark), and Tom Taylor (UD Facilities).

2) Delineate the boundaries of the Cool Run Watershed

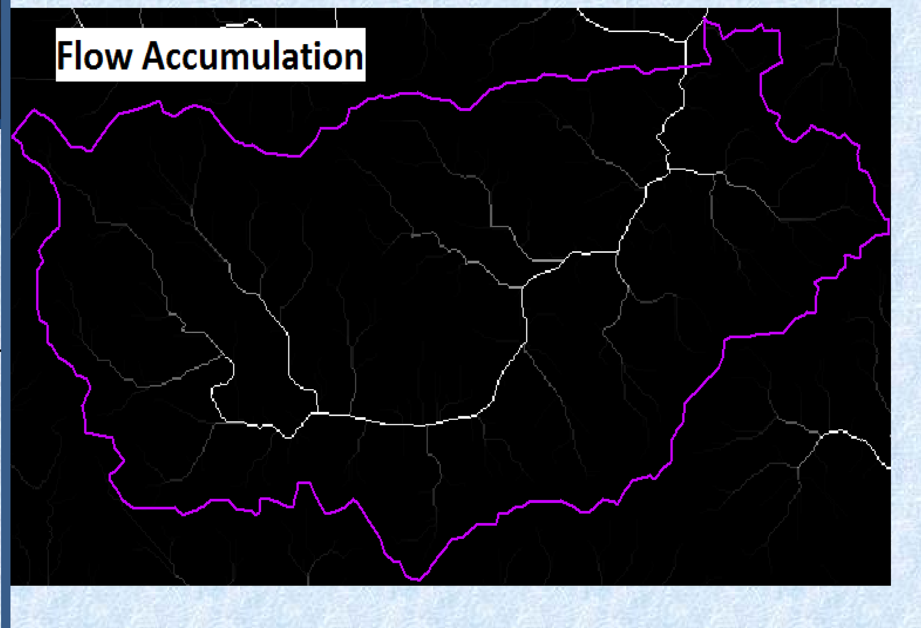


This process required data from the USGS on watershed boundaries. After locating the Upper White Clay Watershed, we split it into sub-basins using ArcMaps "basin" utility. This tool gives each watershed a unique category value, allowing for the selection of a specific one. Clearly, this analysis gives a much more detailed boundary than the hydrologic unit code (HUC) boundary determined by the state.

3) Calculate the flow direction and flow accumulation rasters

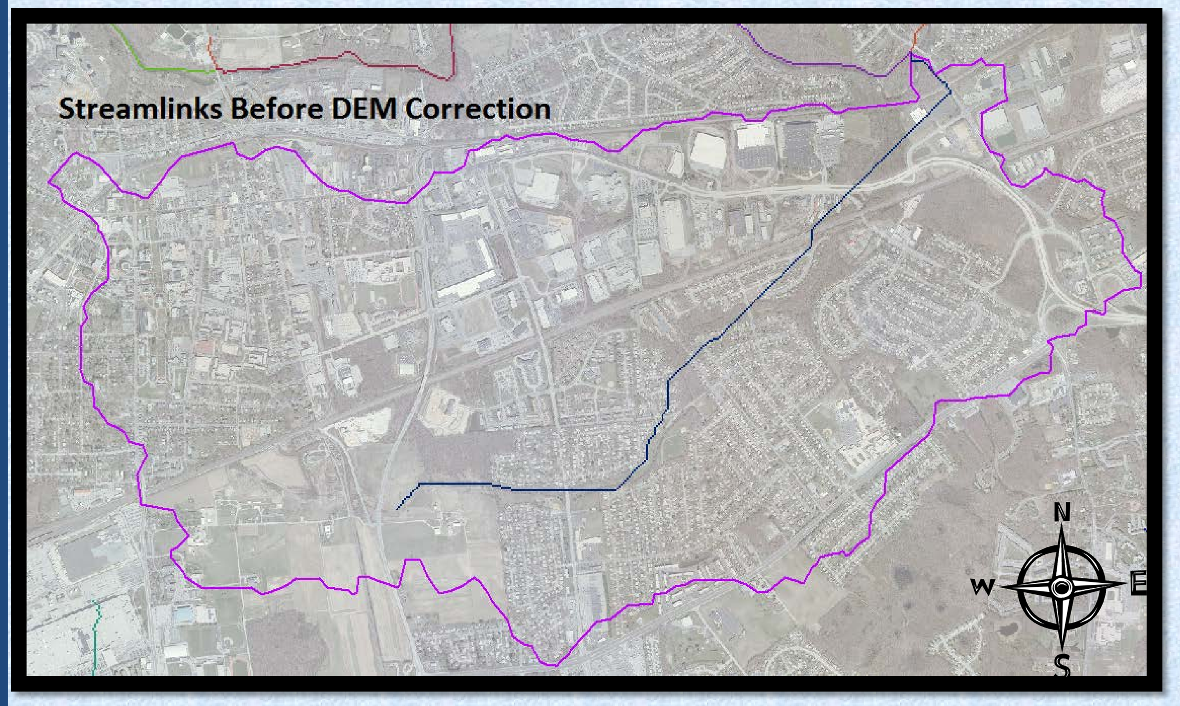


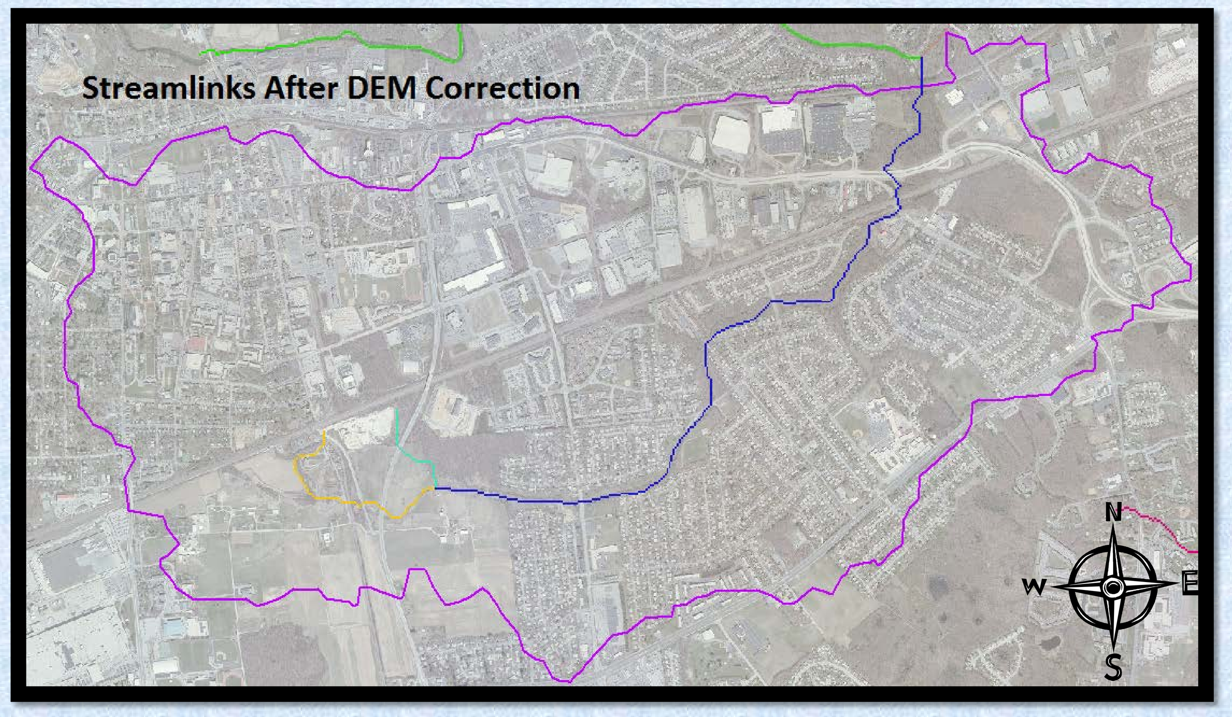
This output map reports the down gradient flow direction for each 10x10 meter cell within the DEM. The visual map output is less important than the raster data itself, which was used to determine flow accumulation and stream channels in the watershed.



This map shows the cumulative number of up gradient cells that drain through each cell in the watershed. The whiter the cell, the more up gradient cells there are that drain to that particular cell. Thus, it is particularly important in carving out the stream channel as is evident in the image on the left.

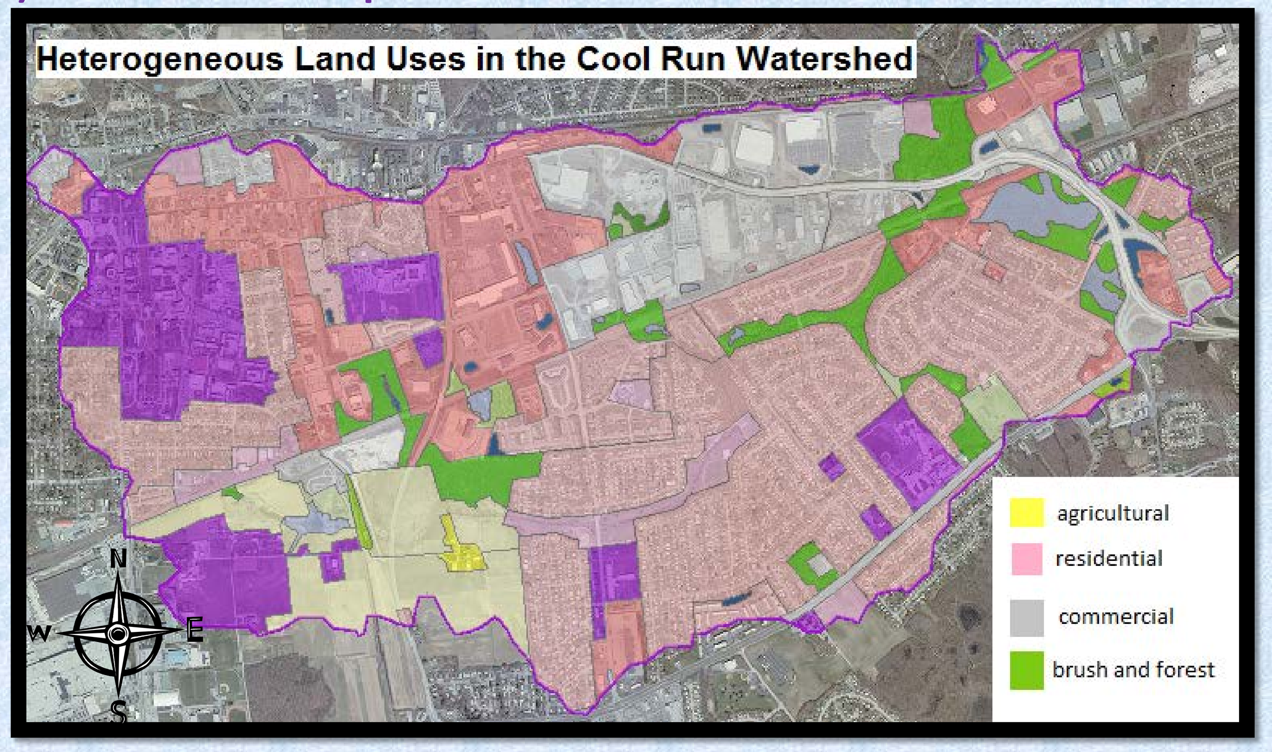
4) Combine stream channels inferred from flow accumulation with actual stream features as targets for runoff modeling

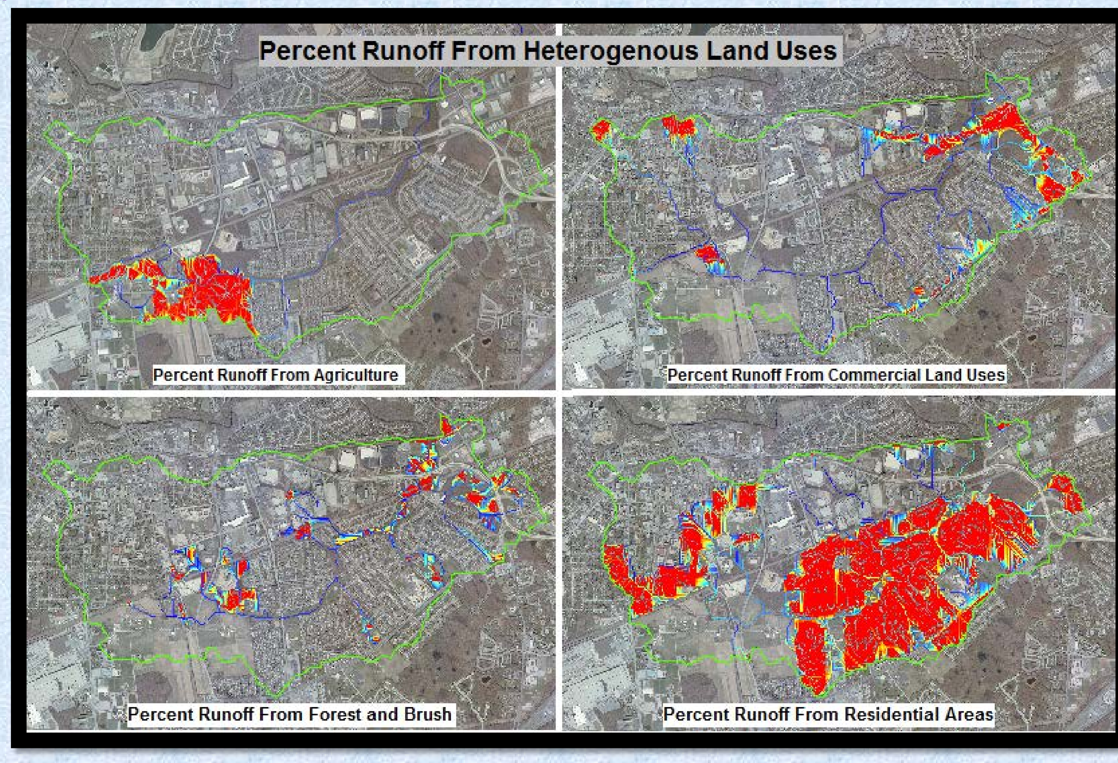




From the Flow Accumulation data and ArcMap's "raster calculator" an inferred streams raster was created. The inferred streams raster gives a value of "1" to all cells that exceed a flow accumulation value of 12,000 and a value of "0" to all other cells. The "streamlink" hydrology tool then gives a unique ID number to each segment of the stream. Above, I have included both streamlink maps to show the obvious difference in streamflow after carving the correct streampath into the DEM.

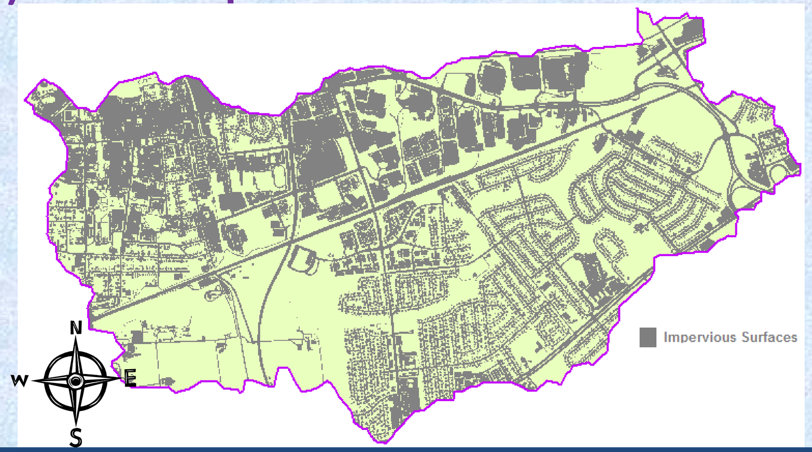
5) Model runoff impacts from each land use within the watershed





Above: The image to the left demonstrates the different land uses within the Cool Run Watershed. Highlighted are the four that have the most impact on runoff and water quality in the Cool Run. The image to the right displays the percent runoff from these four different land uses out of the runoff from the entire watershed. The cool to hot color ramp used suggests that the red areas have the highest percentage runoff into the tributary, while the blue ones have the least impact (for that particular land use type). Clearly, residential areas have the most land with a high percentage contribution to runoff.

6) Obtain impervious surface data to determine where the largest amount of storm water runoff will originate from



Impervious surfaces are mainly artificial structures--such as pavements (roads, sidewalks, driveways and parking lots) that are covered by impenetrable materials such as asphalt, concrete, brick, and stone--and rooftops. These surfaces are a concern because they seal the soil surface and eliminate groundwater percolation and recharge. Runoff from impervious surfaces likely contributes to the majority of pollution in lakes, rivers, and streams. Some of these pollutants include sediment, gasoline, motor oil, excess nutrients, fertilizers, metals, and pathogens.