GEO 3276: GIS & GPS Applications in Earth Sciences

Onion Creek Streamflow

Differences in discharge after urbanization of Austin, TX

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Introduction

Over the past decade, Austin's population has boomed. Some sources cite Austin as one of the fastest growing cities in the United States. As a hydro major, I wanted to see how the urbanization of Austin has affected streamflow. This GIS project will supplement my project on the same topic in Physical Hydrology. To determine fluxes in streamflow, two time periods will be chosen (depending on data available) and compared. Since stream gage data comes from point data, interpolation of the points through the spline technique will be used to predict streamflow in other parts of the watershed. The watershed used will be the Onion Creek watershed due to its large development over the past decade. Accordingly, the question I will try to answer is:

> *What is the difference in discharge after urbanization of Austin, TX?*

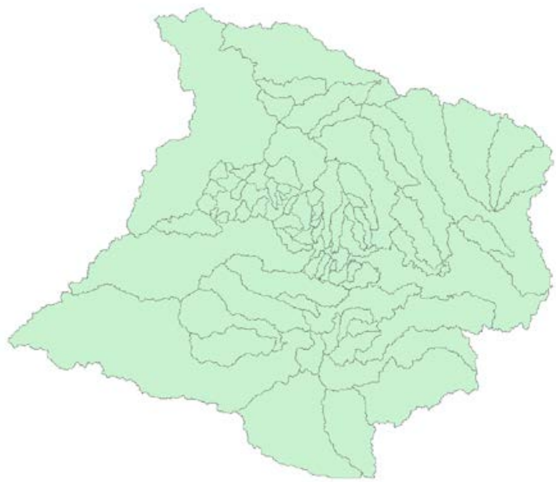
Data Collection

The Austin GIS website was very helpful in having the watershed and creekline shapefiles already on hand. The difficult part came with choosing stream gages that had sufficient data for the report. I checked all the annual discharge records of all the wells in the Onion Creek watershed, and only 5 of them had at least 10 years of data. Thus, the time range was set from 2004-2013.

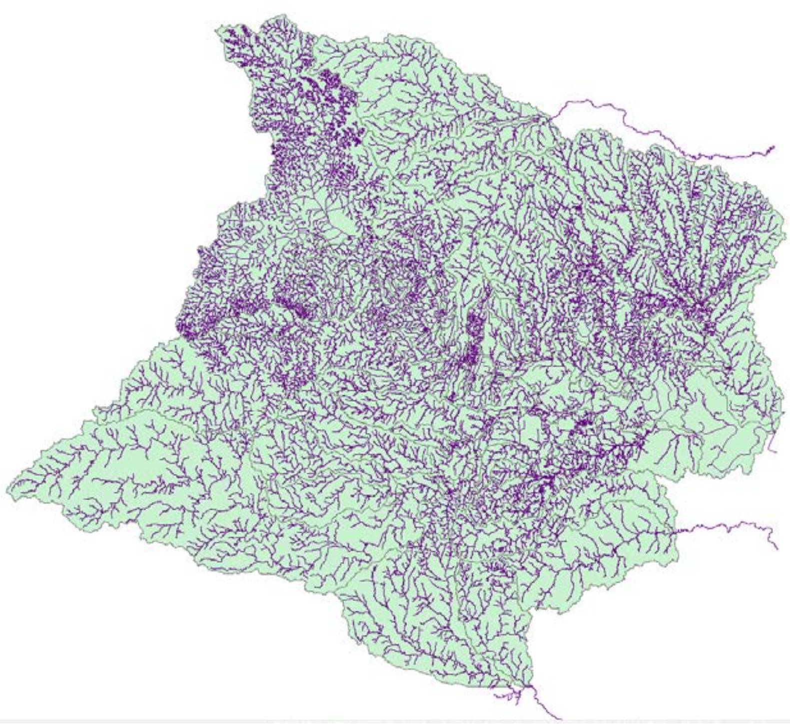
- Austin GIS (ftp://ftp.ci.austin.tx.us/GIS-Data/Regional/coa_gis.html)
  - Shapefile data used:
    - Creek Lines
    - Watersheds
- USGS (http://waterdata.usgs.gov/nwis/rt)
  - Streamflow Discharge
    - Used table data for annual discharge of 5 wells in the area
  - Stream gage well locations
    - http://water.usgs.gov/GIS/dsdl/USGS_Streamgages-NHD_Locations_Shape.zip

ArcGIS Processing

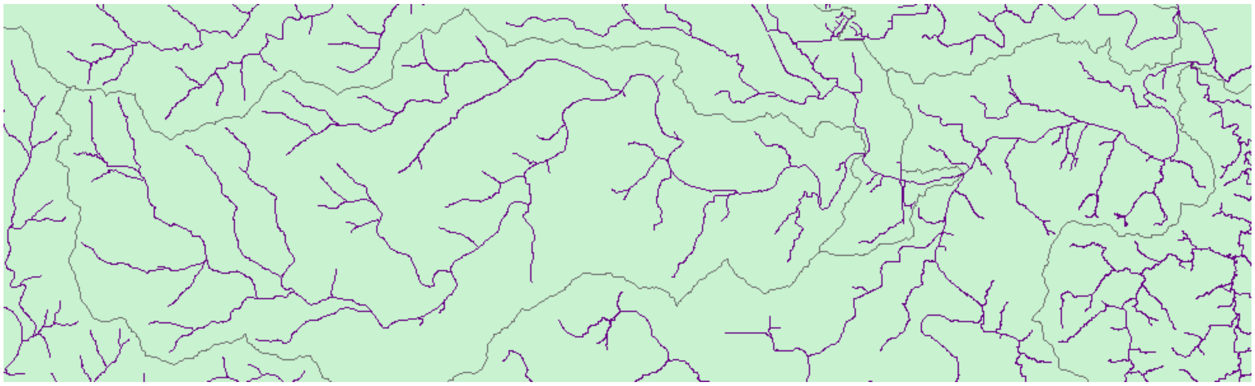
The first step is determining the boundaries of the Onion Creek watershed. To do so, I added the watershed shapefile to begin framing my reference. Only the bottom left watershed is identified as Onion Creek.



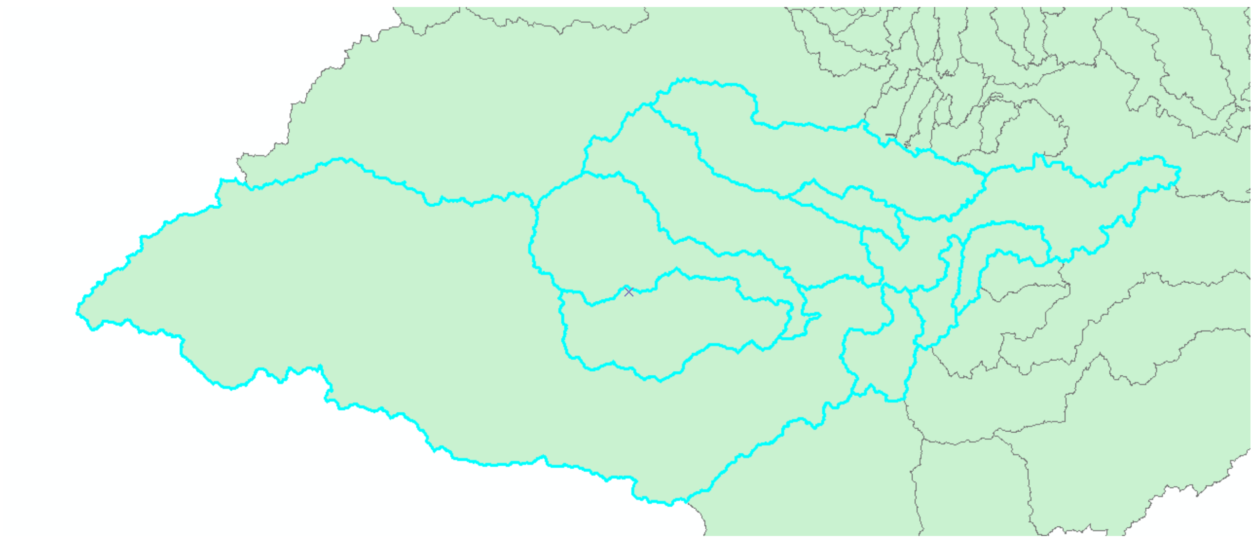
In order to find out the tributaries to the mouth of the Onion Creek watershed, I overlaid the creekline shapefile ontop of the watershed shapefile.



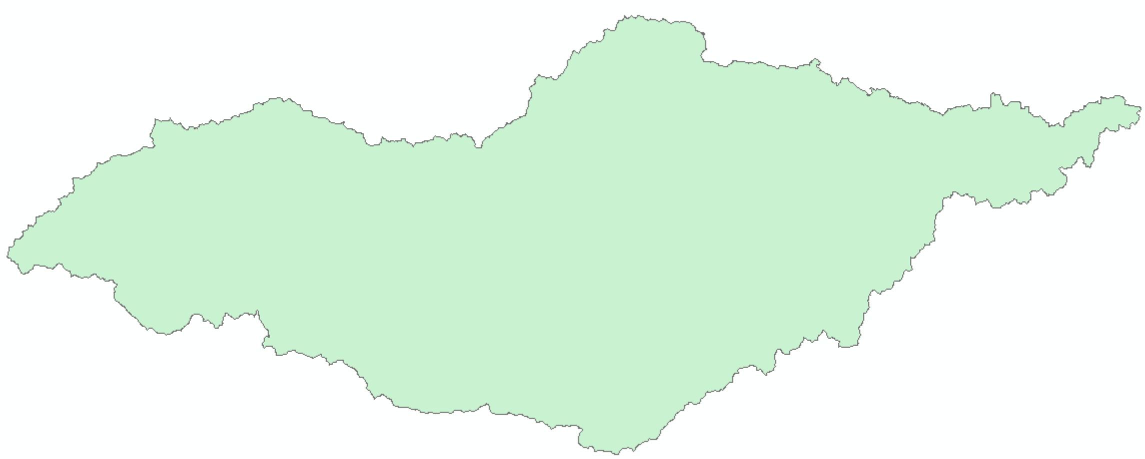
Zooming in, I could see the miniature watershed boundaries and could determine if they eventually flowed into the main Onion Creek watershed.



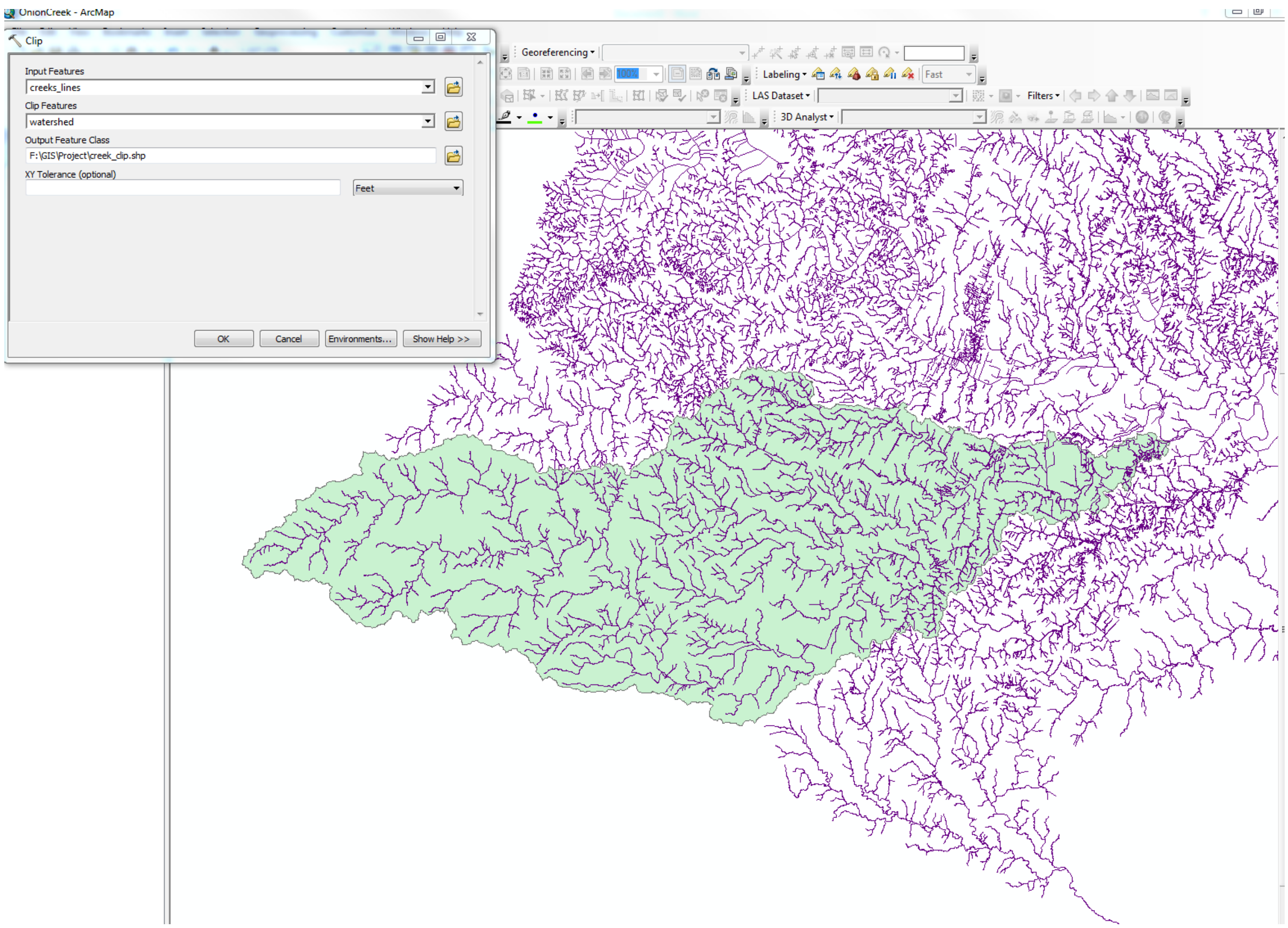
In edit mode, I selected the contributing watersheds to the main Onion Creek watershed.



Then, I merged them into one feature. I selected the remaining of the watersheds and deleted them from the layer as they are of no more use.

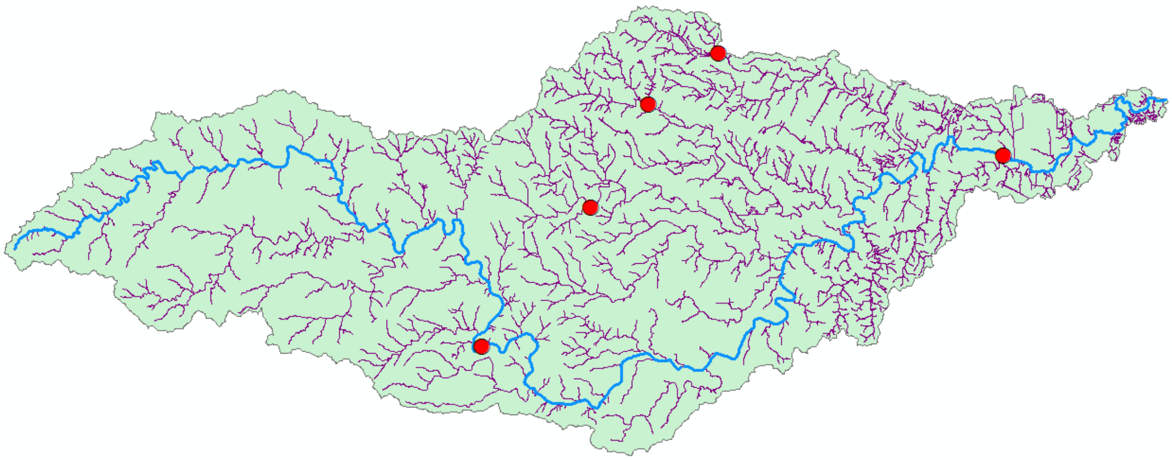


Next, I used the clip tool to clip the creeklines to the merged Onion Creek watershed.

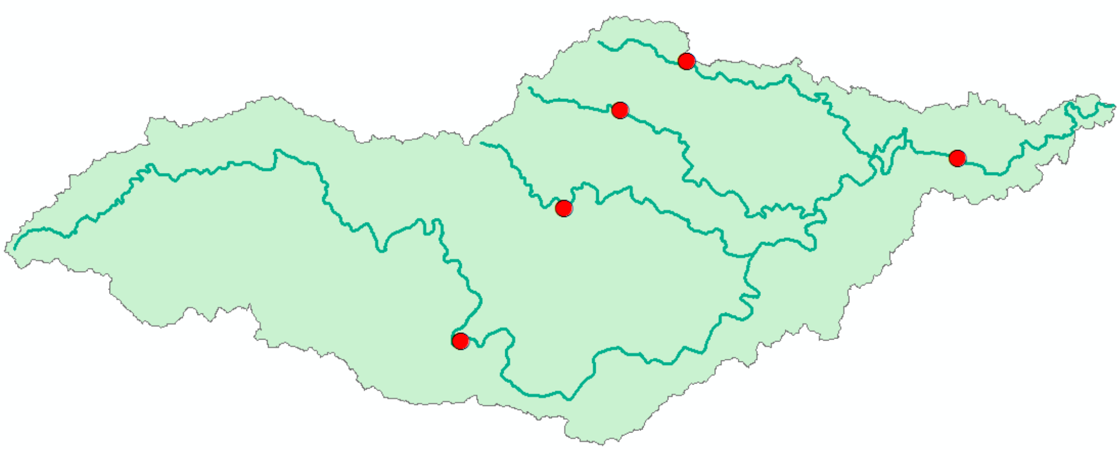


Just to keep a frame of mind, I also merged all the line segments along the main channel of Onion Creek.

To add the stream gage locations, I added the shapefile to the map, and selected the 5 gages I needed to keep. I deleted the rest of the gages from the layer.

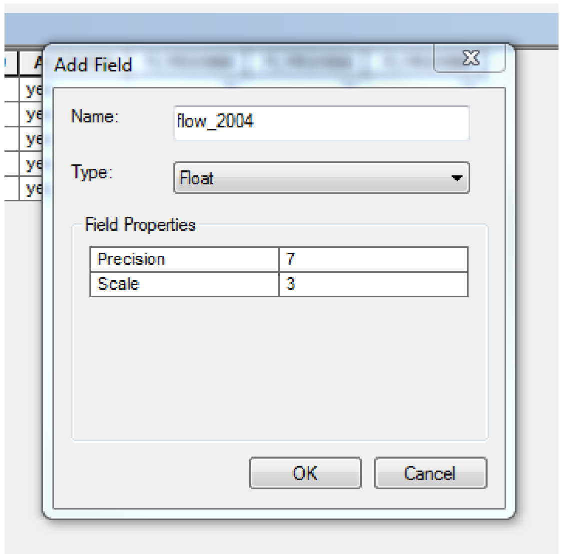


To keep the final interpolated surface to the main streams, I merged the main channels of their respective streamgages. Then I deleted the rest of the creek lines from the layer. If I had kept the creekline and not the main channels, the small tributaries to the east of the map would show high velocity, but that's not true. Only the main channels receive the surrounding water and pick up in velocity.

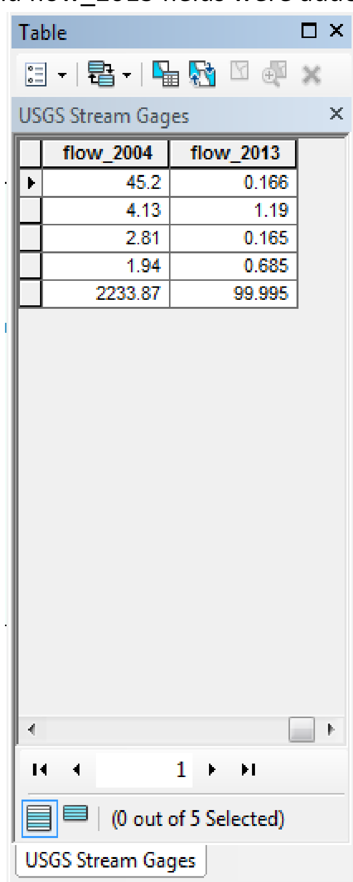


This concludes forming the basemap for the remainder of the project.

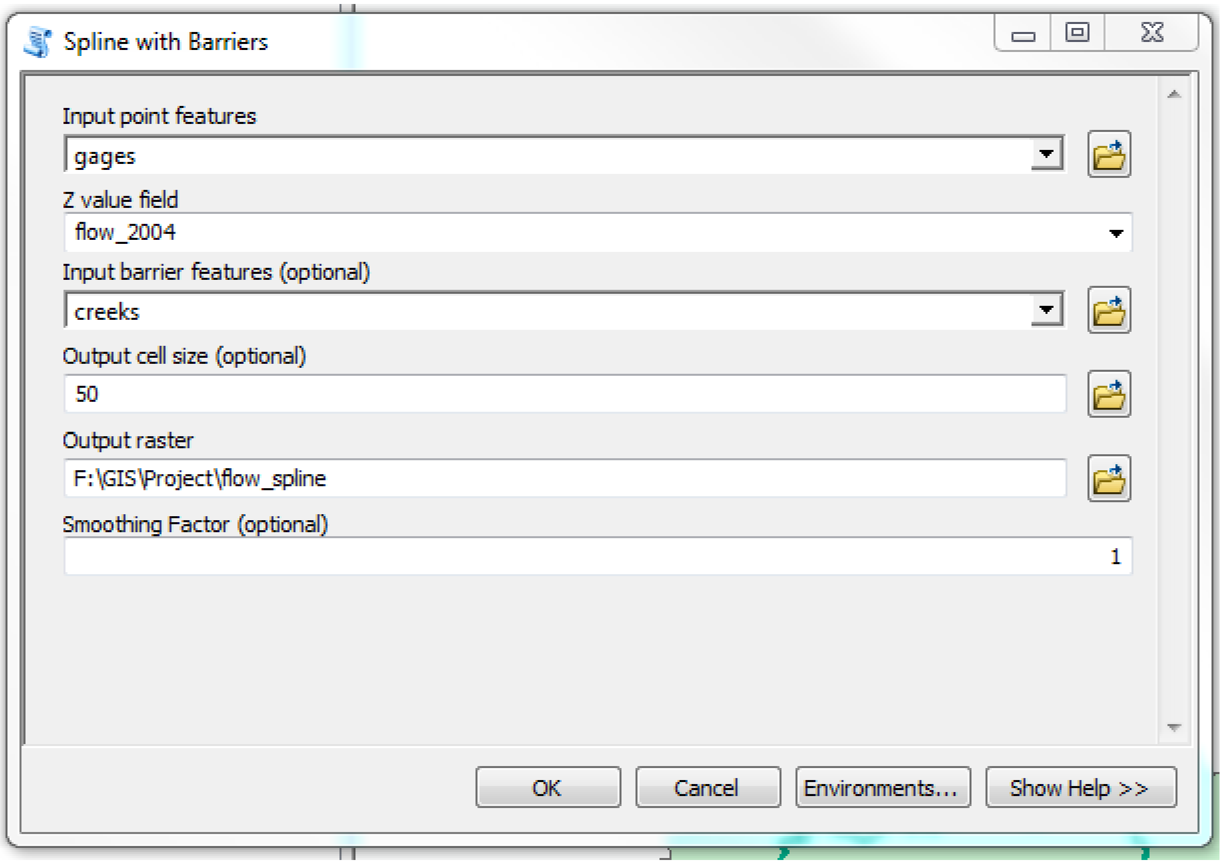
To add the discharge data to the gage layer, I added Float fields to the attribute table. In order to accomadate the length of my number data, I used a precision (number of digits) of 7 and a scale (number of decimals) of 3.



The resulting flow_2004 and flow_2013 fields were added to their respective gages.

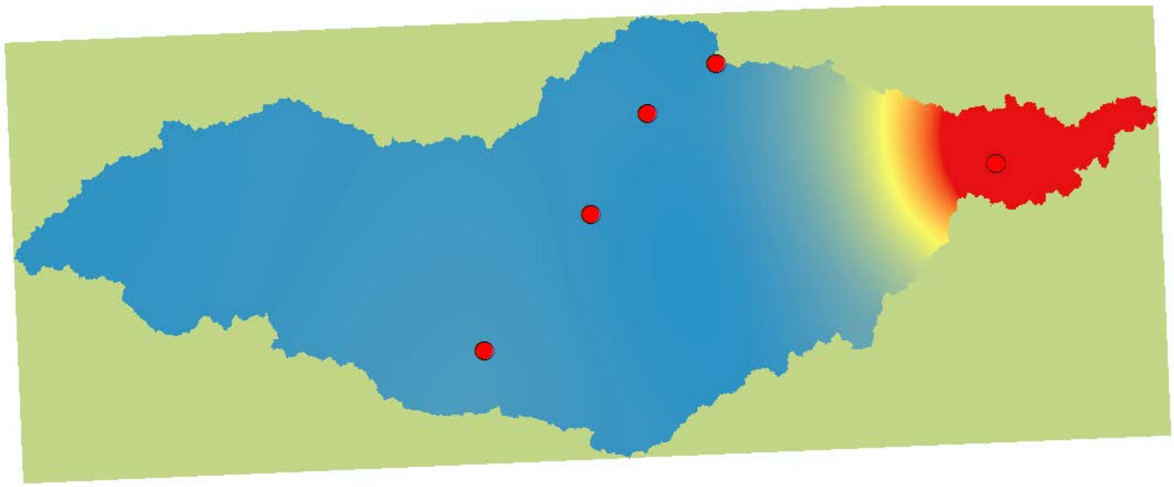


The next step in this project was to interpolate the data between the streamgage points to predict discharge at other parts of the streams. Since I only have 5 data points and a large extent, I used the spline technique. In addition, I used the Spline with Barriers tool as I wanted to keep the interpolation to the watershed boundary.

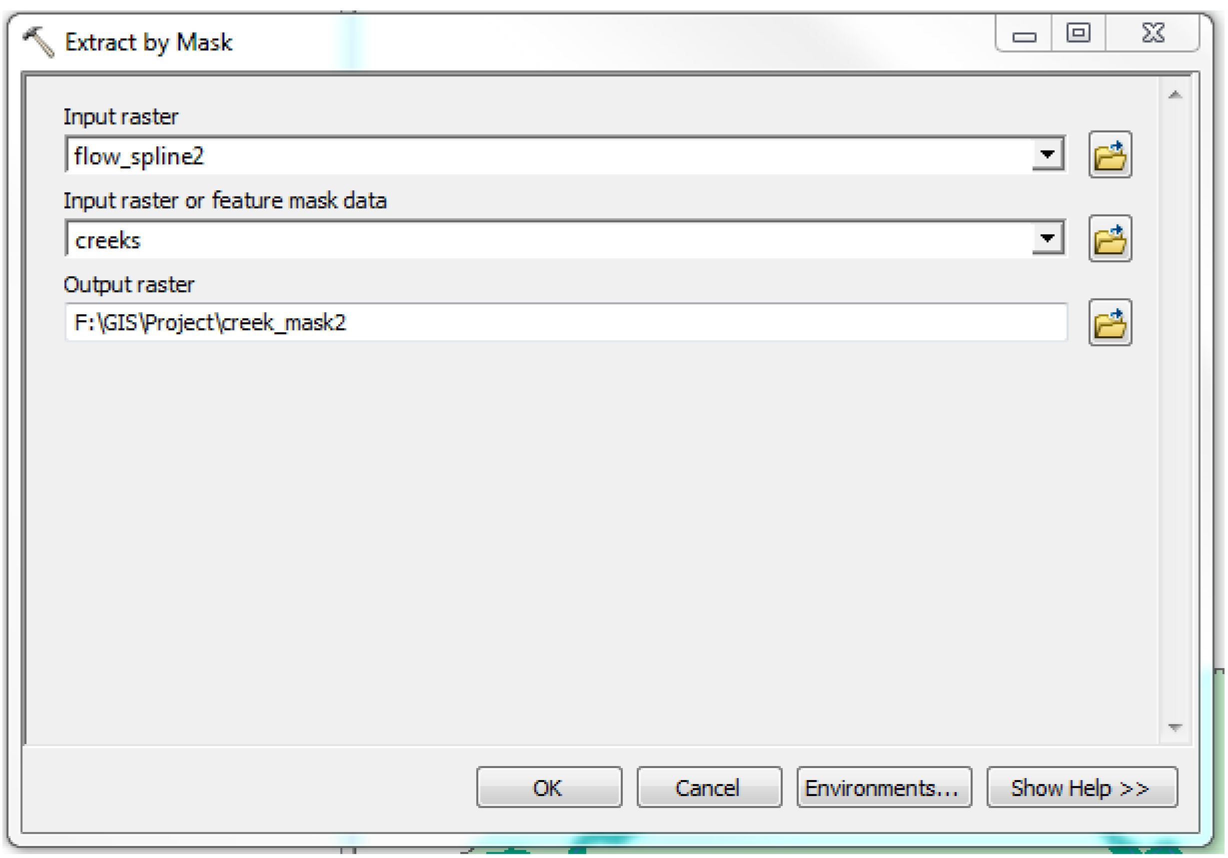


To use the tool, these were my initial values. The input point data was the gages layer. And the output discharge data will be retained to the creeks. I changed the smoothing factor from 0 to 1 as I wanted to keep the resulting raster as smooth as possible.

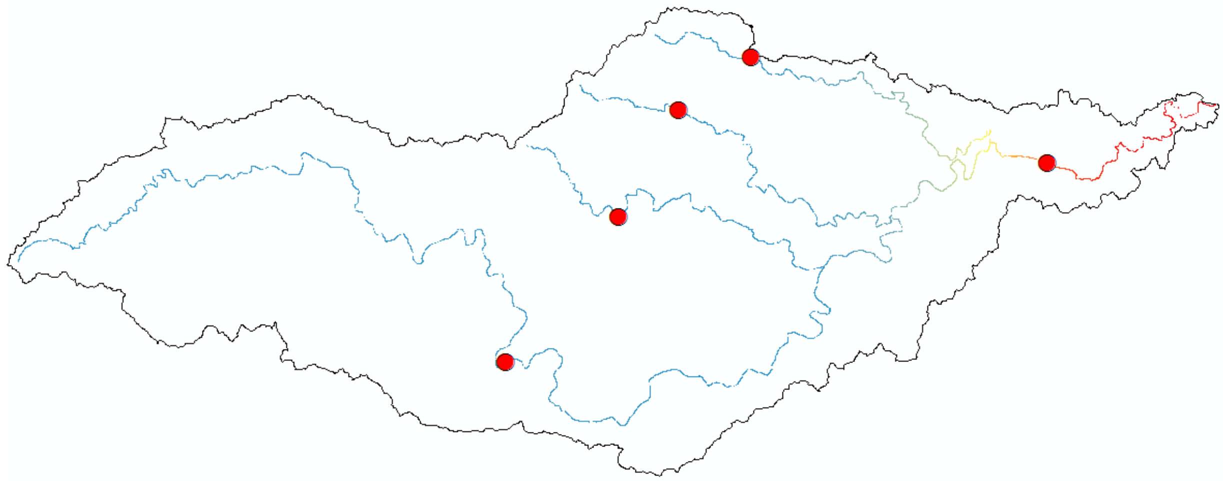
The resulting raster shows great definition of the discharge data, but it has an excess rectangle outside of the watershed boundary.



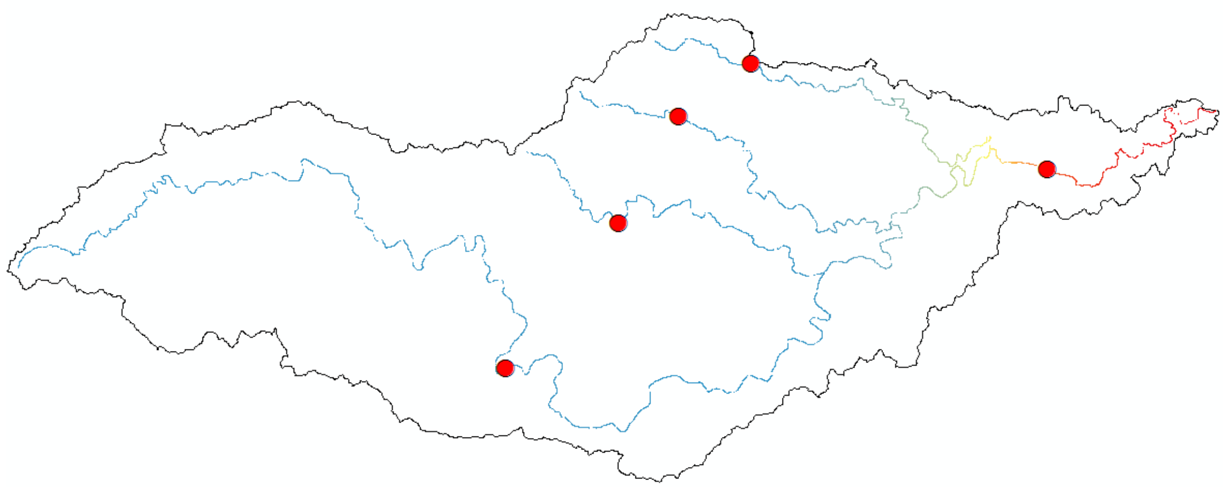
The spline tools do not allow for masks, thus I used the Extract by Mask tool in order to crop the interpolated raster to just the main creek lines.



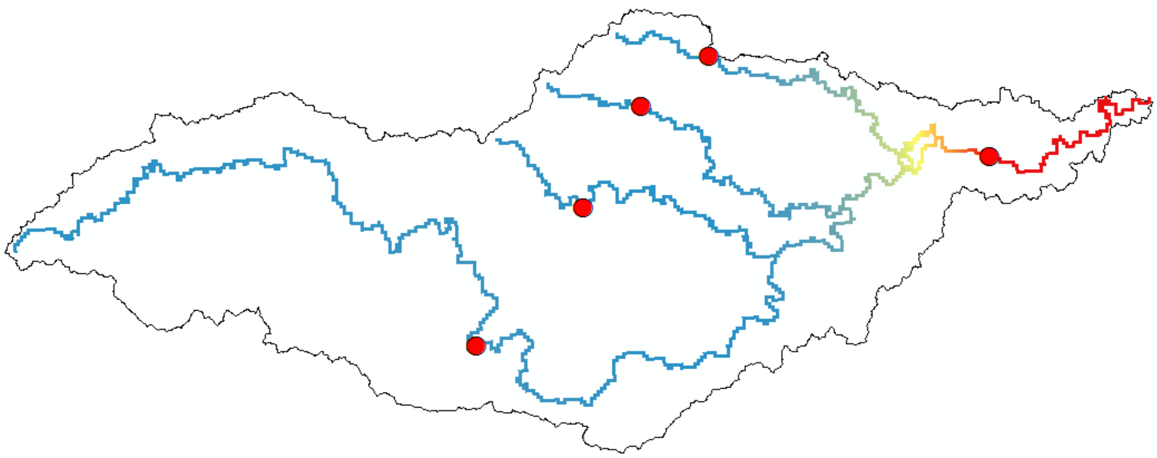
The resulting map shows the interpolated range of colors confined to the creek lines.



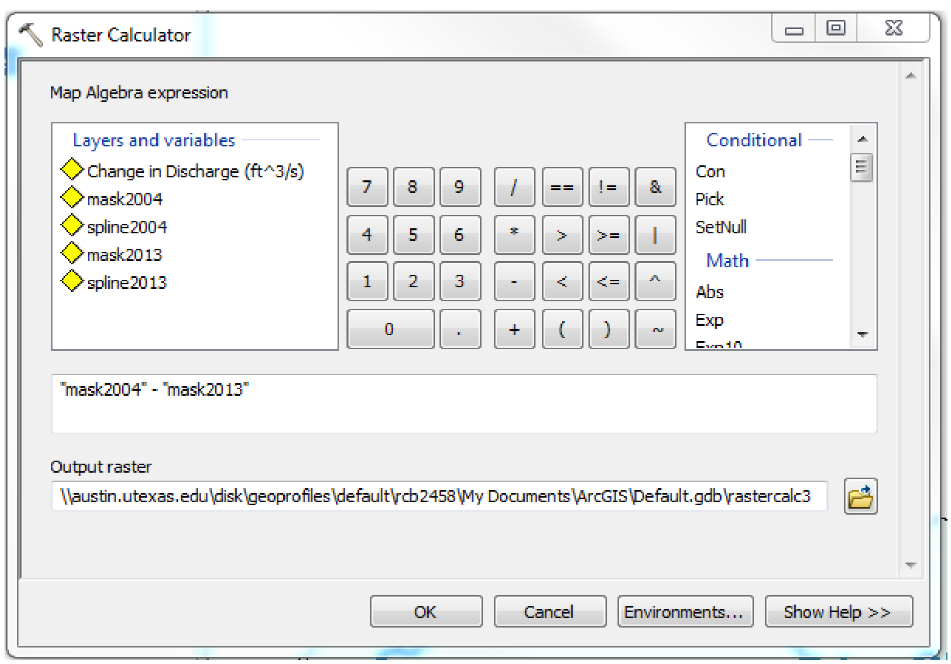
To create the 2013 map, I followed the exact methods as above, except using the flow_2013 field for spline interpolation. The resulting graphs looks very very similar to the 2004 graph.



I decided that the creek lines were too skinny, and so the only way I could figure out to make them thick was to increase the output cell size when splining. I change the cell size from 50 to 200. The resulting map has much thicker creek lines and the color differences are more discernible. The downside is that the creeks are now blocky due to the rectangular nature of rasters. I completed the cell size change for both 2004 and 2013.



The objective of this project was to find the difference between the two years. Thus, the Raster Calculator tool was used to subtract the 2013 discharge from the 2004 discharge.

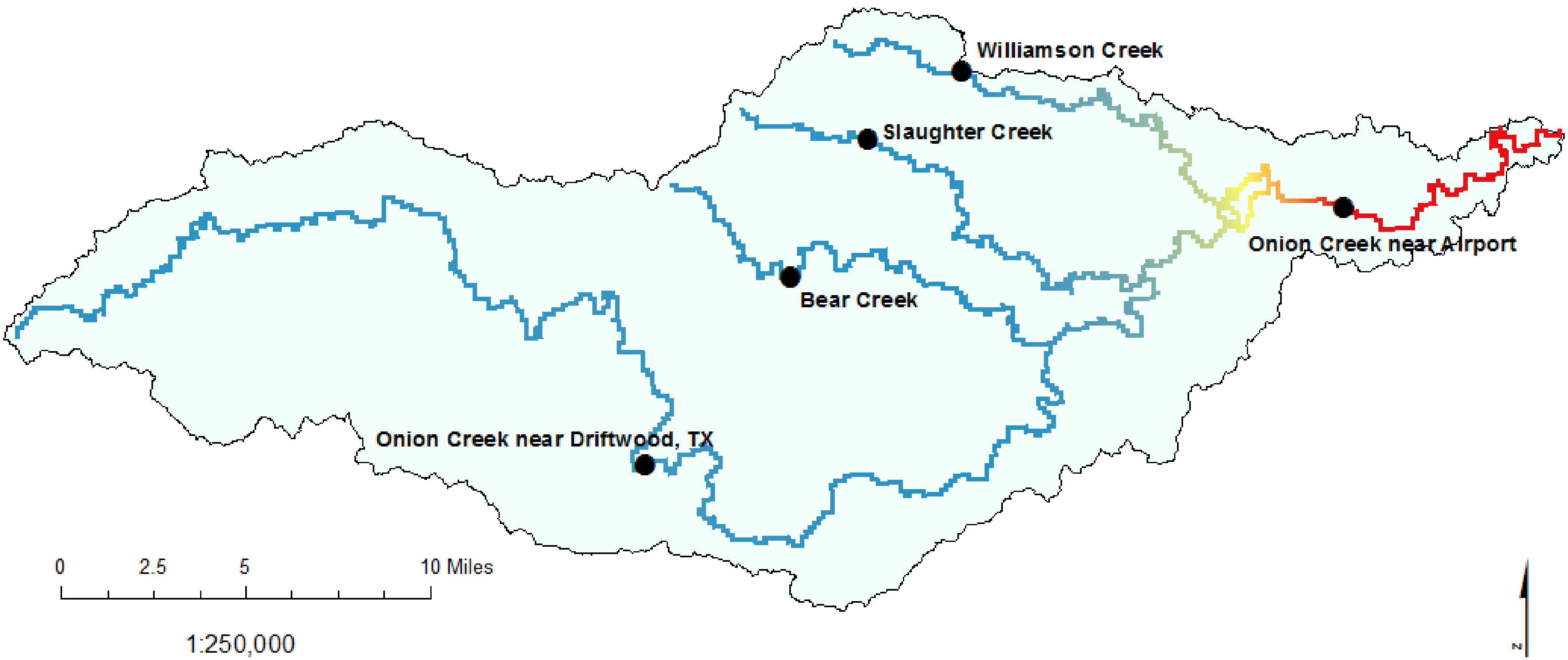


Results

The results are on the following page.

Mapped by Richard Bagans 12/2/14

Difference in Annual Discharge from 2004 to 2013 of the Onion Creek Watershed in Austin, TX



Coordinate System: NAD 1983 StatePlane Texas Central FIPS 4203 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
False Easting: 2,296,583.3333
False Northing: 9,842,500.0000
Central Meridian: -100.3333
Standard Parallel 1: 30.1167
Standard Parallel 2: 31.8833
Latitude Of Origin: 29.6667
Units: Foot US

Legend

Onion Creek Watershed

USGS Stream Gages

Change in Discharge (ft^3/s)

High : 2485.14

Low : -20.6176

Conclusions

Even though the final map shows very little change from the original discharge maps, there is a very important conclusion to make. Since the shading of the difference map is so similar, this means that the streamflow discharge decreased linearly from 2004-2013. Another conclusion is that the streamflow decreased rather than the hypothesized increase due to impervious cover. Although it may seem it has decreased, further analysis of the Barton Creek watershed, a watershed with minimal impervious cover, has decreased at an even faster rate the Onion Creek watershed shown above. Thus, the Onion Creek watershed does have increased discharge from impervious cover as it is decreasing at a slower rate than an undeveloped watershed.