Exercise 2

Prepared by David R. Maidment and David G. Tarboton
Updated to ArcGIS Pro by Paul Ruess, August 2016

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Goals of the Exercise

This exercise is intended for you to build a base data set of geographic information for a watershed using the San Marcos Basin in South Texas as an example. The base dataset comprises watershed boundaries and streams from the National Hydrography Dataset Plus (NHDPlus). In addition, you will create a point Feature Class of stream gage sites by inputting latitude and longitude values for the gages in an Excel table that is added to ArcMap and the geodatabase. You will create a resource in Hydroshare of the San Marcos Basin and use it as a backdrop to download forecasts from the National Water Model.

Computer and Data Requirements

To complete this exercise, you'll need to run ArcGIS Pro from a PC. You will download hydrologic information to do this exercise from HydroShare and other online data sources.

Procedure for the Assignment

Getting Started

We'll begin by getting the input data for Water Resource Region 12, and creating a new, empty geodatabase into which you'll put data for the San Marcos basin, which is a small drainage area within this region.

Open the ArcGIS Online map at: http://arcg.is/1JW0DBm This map is publicly shared so you don't need to login to ArcGIS Online to use it. Click on the **Texas Gulf** region. If there is no response, try another browser.

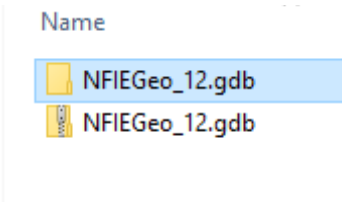
Then click on **More info**

And scroll down to **Content**

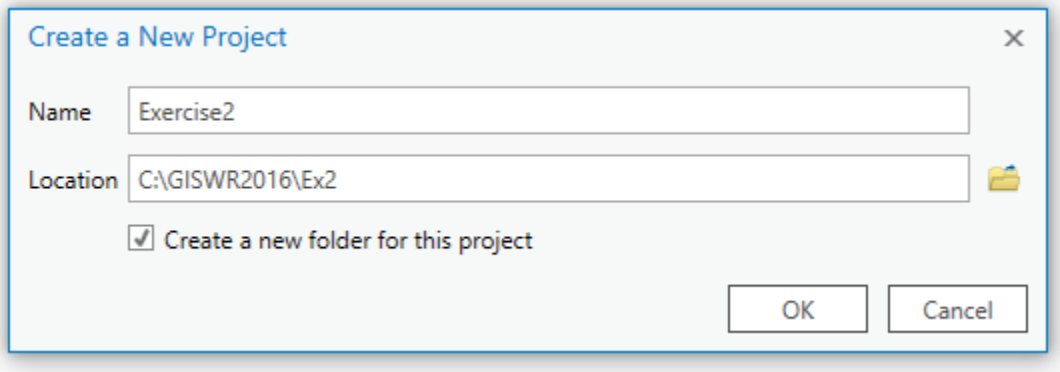
Download the file **NFIEGeo_12.gdb.zip** (127.1MB). If you have trouble locating this file, you can get it directly at:

https://www.hydroshare.org/resource/1d78964652034876b1c190647b21a77d/

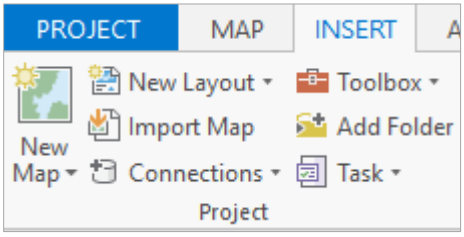
Unzip this file and navigate down through the folders to a zipped geodatabase file, and unzip that. Move the geodatabase file to your working directory for this exercise.



Open ArcGIS Pro and create a new Project file for this exercise. I have called this **Exercise2**. It's a good idea to just use one word titles for projects because this is the name of the Geodatabase that you create within the project. In general, ArcGIS likes to have single word titles as the names for things or otherwise you have to interpret spaces and that can be ambiguous.

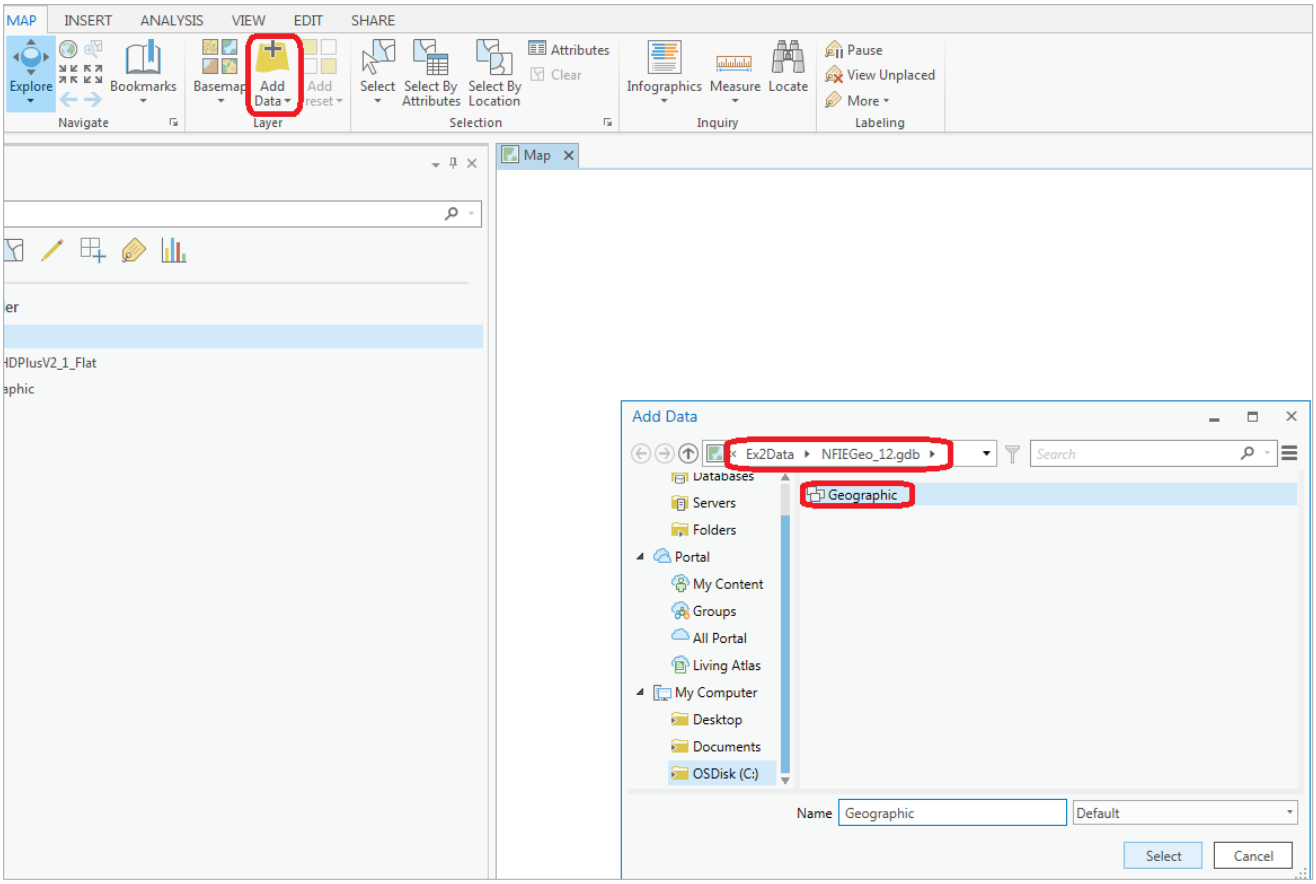


Insert a **New Map** into your view

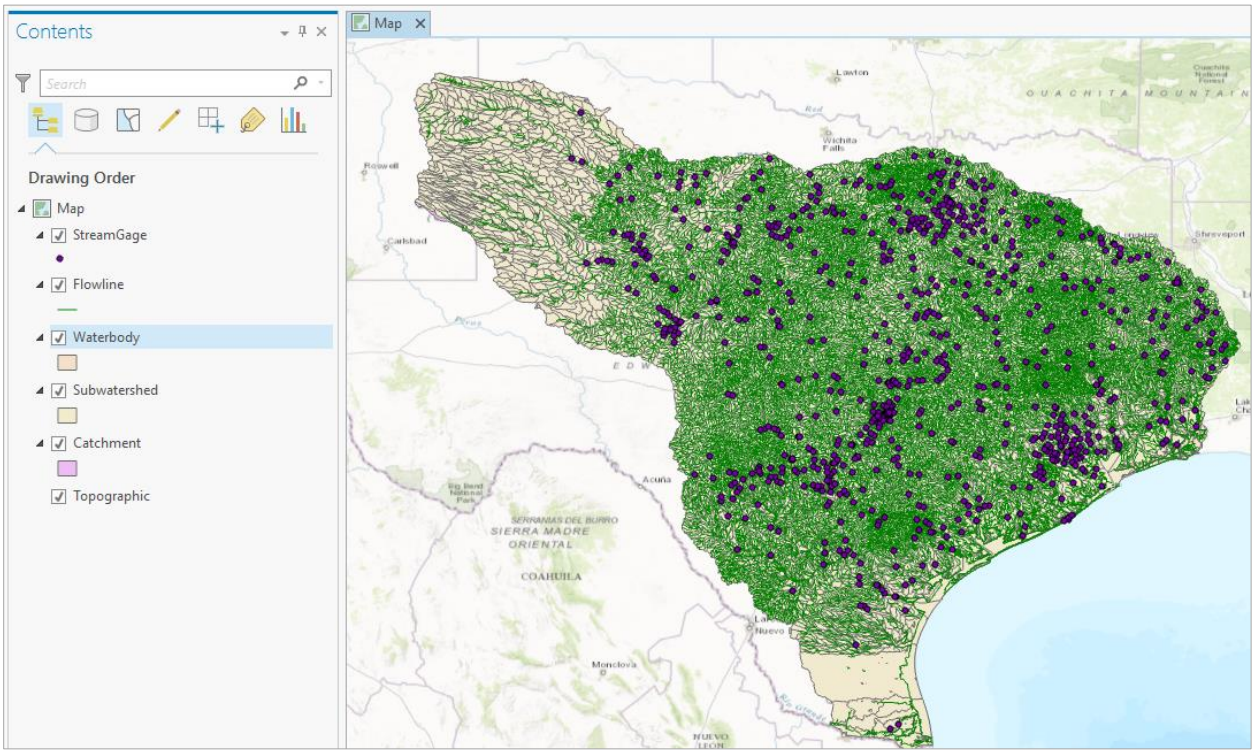


And you'll see a big topographic map of the United States show up.

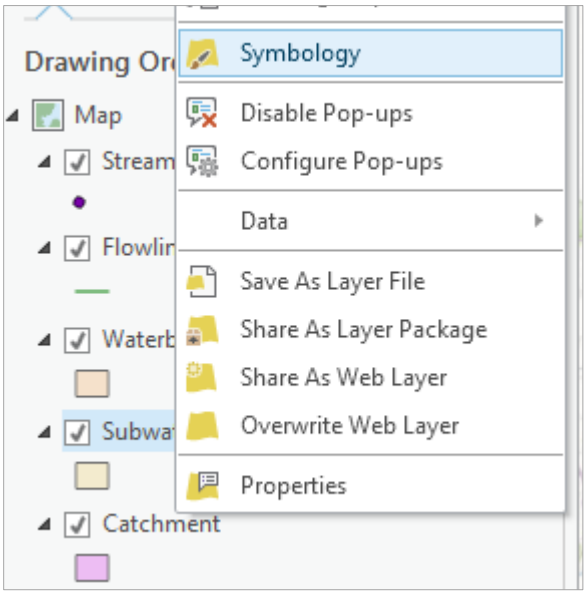
Add the **NFIEGeo_12** data to the map by using the **Add Data** button and navigating to the Feature Dataset **Geographic** data.



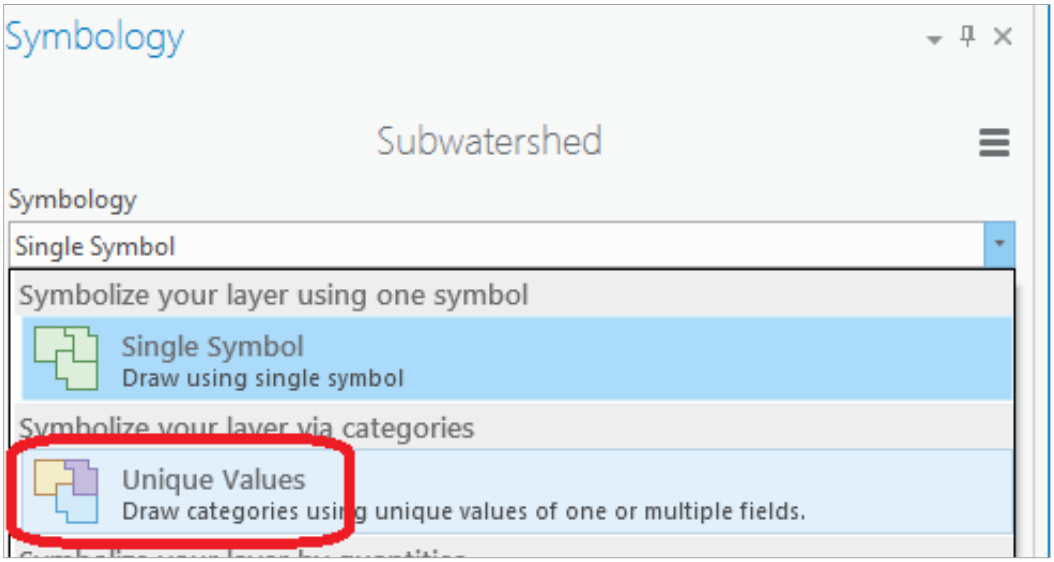
This adds all the feature classes in this feature dataset to your map view.



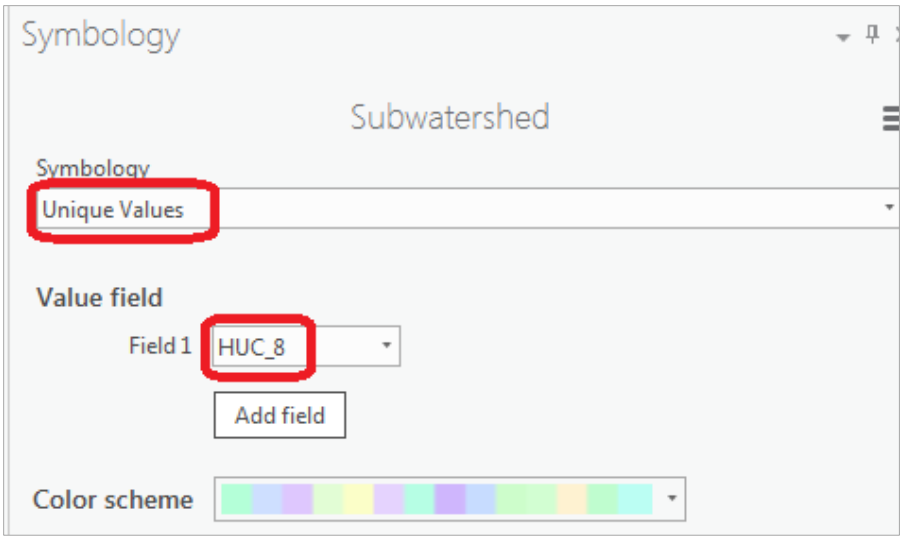
You'll see that there are five feature classes in this **Geographic** feature dataset. Turn off the display of all feature classes except for **Subwatershed** and recolor the Subwatersheds using the HUC_8 attribute using Unique Values. Right Click on the Subwatershed feature class and select **Symbology**



and in the **Symbology** window that opens on the right hand side click on the **Single Symbol** bar and change this to **Unique Values**

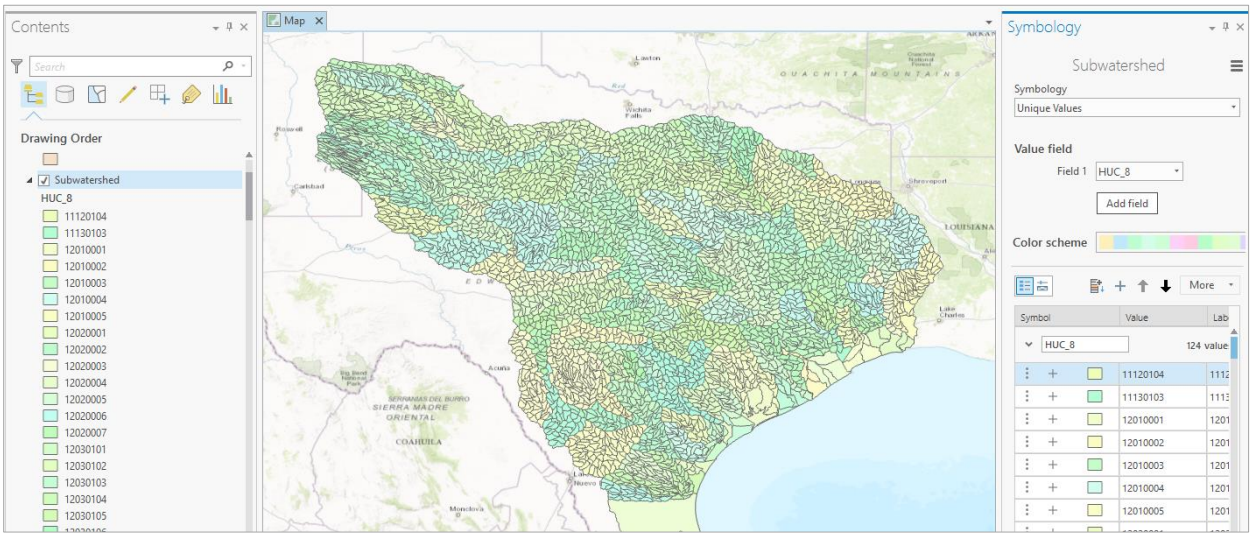


And select **HUC_8** as the Field to be used to display these values



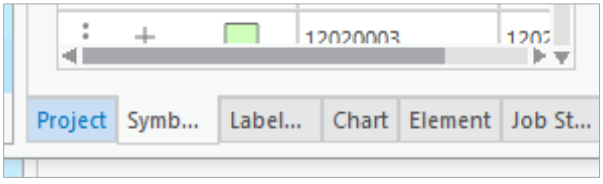
You'll be asked a question as to whether you want more than 100 Unique values, and answer **Yes** to this question.

Your resulting map should look something like this (the colors may be different on your map). The different colors represent HUC8 Subbasins and the outlines are HUC12 Subwatersheds. You can change the default color scheme that you get by clicking on **Color scheme** in the Symbology window and selecting a new one.

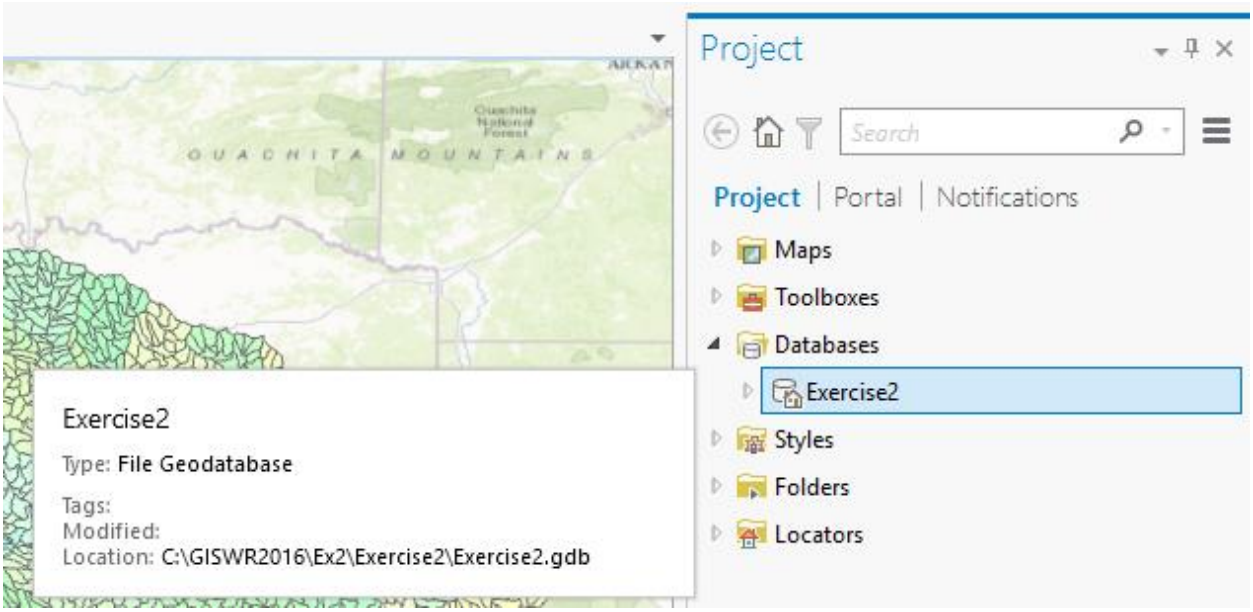


Use **Project/Save** to save the current version of your project so you don't have to recreate this map display again. The project is saved in a file **Exercise2.aprx**, in the folder **Exercise2**.

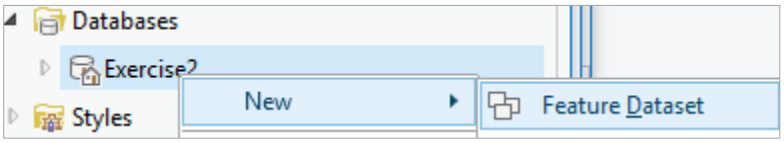
At the bottom of the Symbology window, click on the **Project** tab to open the **Project** window



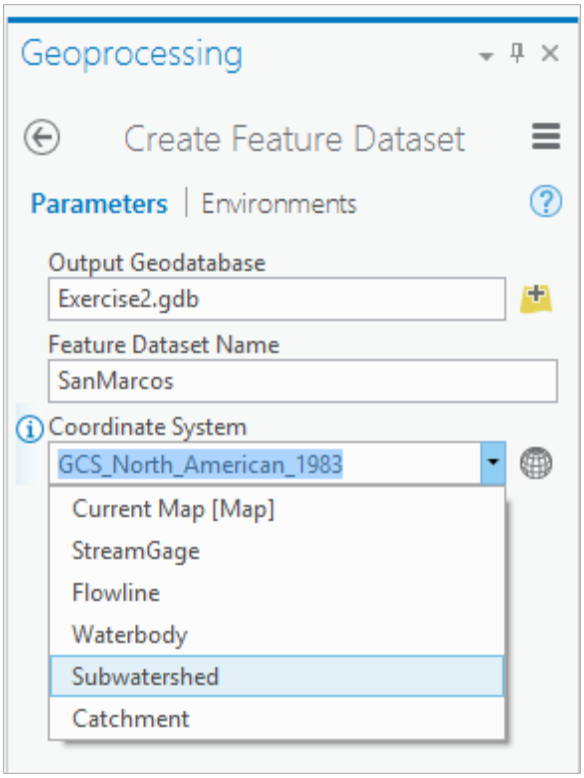
If you open up the Databases section of the display, you'll see a new Geodatabase already created for you called **Exercise2**, consistent with the name of the Project that we created when opening ArcGIS Pro.



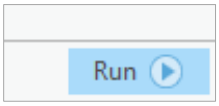
Right click on this **Exercise2** Geodatabase and create a new **Feature Dataset**.



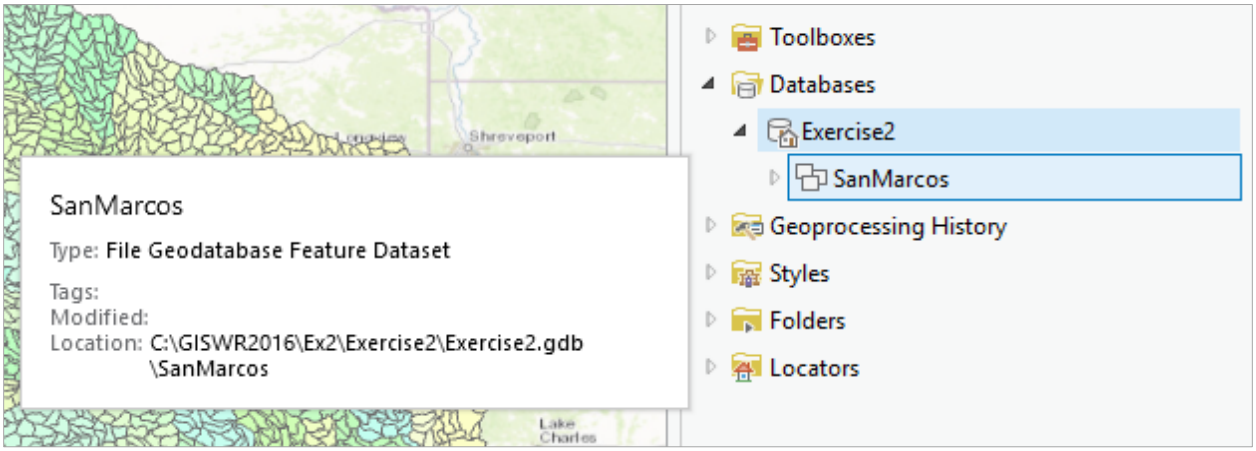
Call this new dataset **SanMarcos** (again, just use one word titles for files) and select the coordinate system for the **Subwatershed** class you are working with. This is a geographic coordinate system defined on the NAD83 datum, or North American Datum of 1983: **GCS_North_American_1983**.



Hit **Run** at the bottom of the tab to execute this action. Notice that you are in a new Tab now called **Geoprocessing**, which indicates that you are creating new information.



If you go back to the Project tab, and expand the Exercise2 geodatabase, you'll see its got a **SanMarcos** feature dataset inside it now, which will hold the data that you create for the San Marcos Basin.

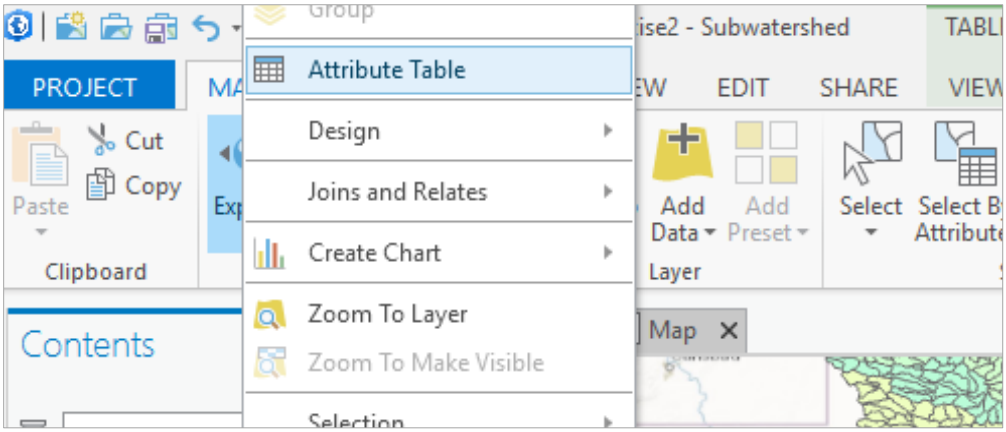


Selecting the Watersheds in the San Marcos Basin

Let's zoom into the San Marcos basin.

We want all the HUC12 subwatersheds that lie within the San Marcos subbasin, which has a HUC8 value of 12100203; these are the first 8 digits of the HUC12 identifier.

Open the Attribute Table of the Subwatershed feature class by right clicking on the **Subwatershed** in the Map view and selecting **Attribute Table**



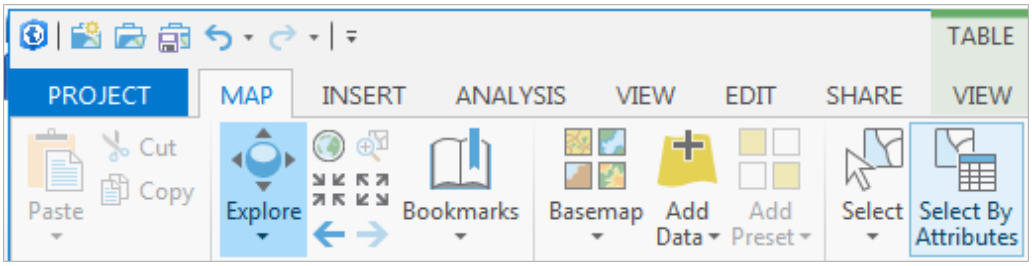
A window like this will open up in your map display.

Subwatershed

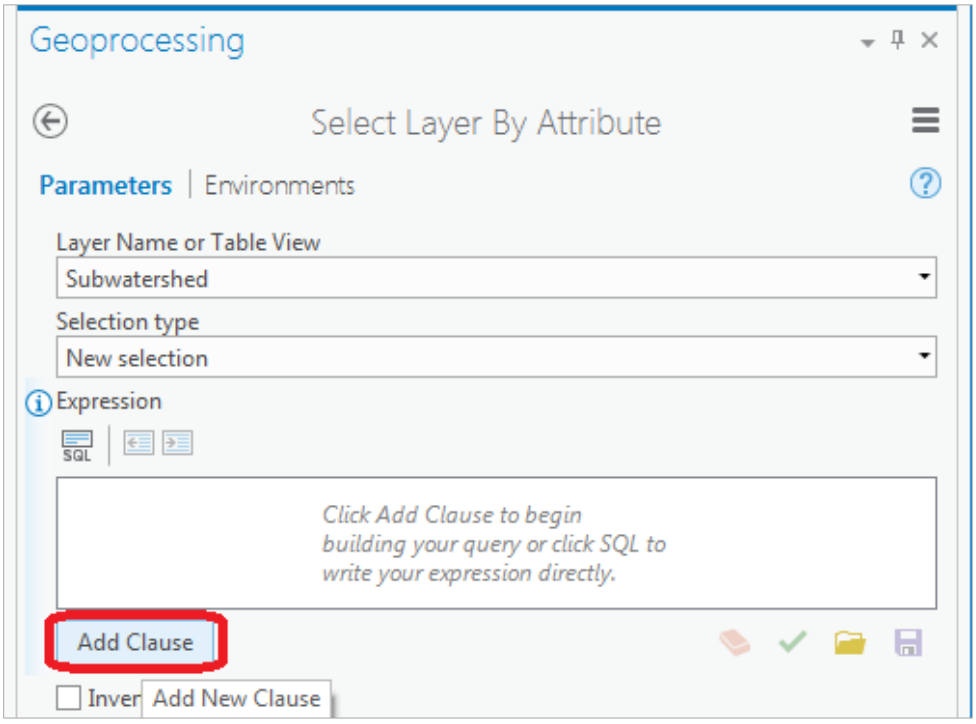
Field: New Delete Calculate Selection: Zoom To Switch Clear Delete

OBJECTID_1	Shape	OBJECTID	HUC_8	HUC_10	HUC_12	ACRES	NCONTRB_A	HU_10_GNIS	HU_12_GNIS
1	Polygon	212912	12110208	1211020806	121102080600	105412	0	0	0
2	Polygon	212913	12110208	1211020807	121102080700	83558	0	0	0
3	Polygon	212914	12110208	1211020808	121102080800	178671	0	0	0
4	Polygon	212915	12110208	1211020803	121102080300	289845	0	0	0
5	Polygon	212917	12110208	1211020810	121102081000	175787	0	0	0
6	Polygon	212918	12110208	1211020804	121102080400	229107	0	0	0
7	Polygon	212919	12110208	1211020805	121102080500	227239	0	0	0
8	Polygon	226615	12110208	1211020802	121102080200	177049	0	0	0
9	Polygon	226660	12110208	1211020809	121102080900	232263	0		
10	Polygon	226661	12110208	1211020801	121102080100	109630	0	0	0
11	Polygon	122292	12070104	1207010403	120701040309	23541	0	0	0
12	Polygon	122301	12040202	1204020204	120402020400	156240	0	0	0
13	Polygon	122302	12040104	1204010401	120401040103	17390	0		
14	Polygon	122308	12040104	1204010403	120401040305	13048	0		
15	Polygon	122310	12040104	1204010407	120401040701	26118	0		1374181
16	Polygon	122709	12090402	1209040202	120904020204	40574	0	0	0
17	Polygon	122748	12090401	1209040103	120904010308	45599	0		
18	Polygon	122753	12090402	1209040203	120904020300	160389	0	0	0

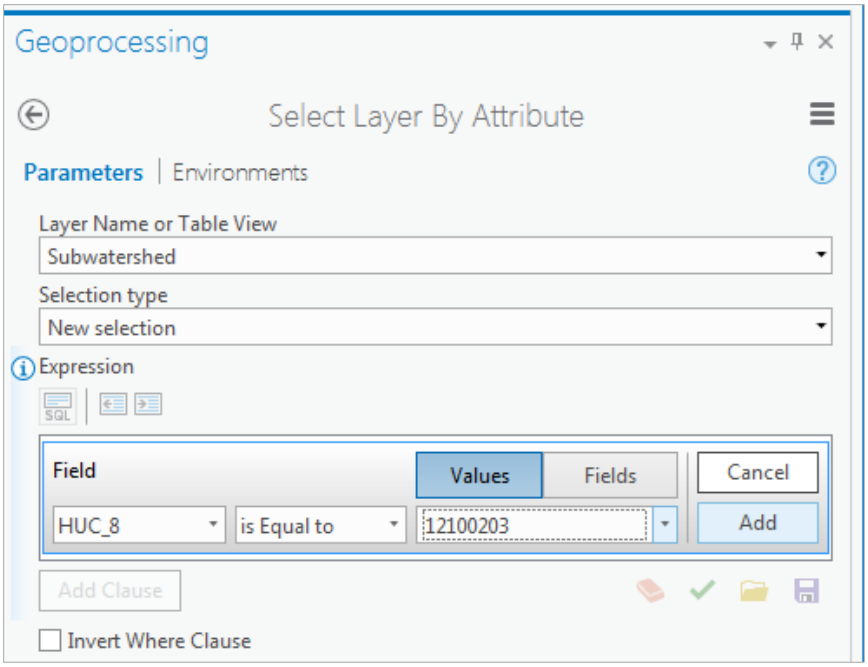
Now let's select some records in this table that describe the San Marcos Basin. In the **Table View**, choose **Select by Attributes**



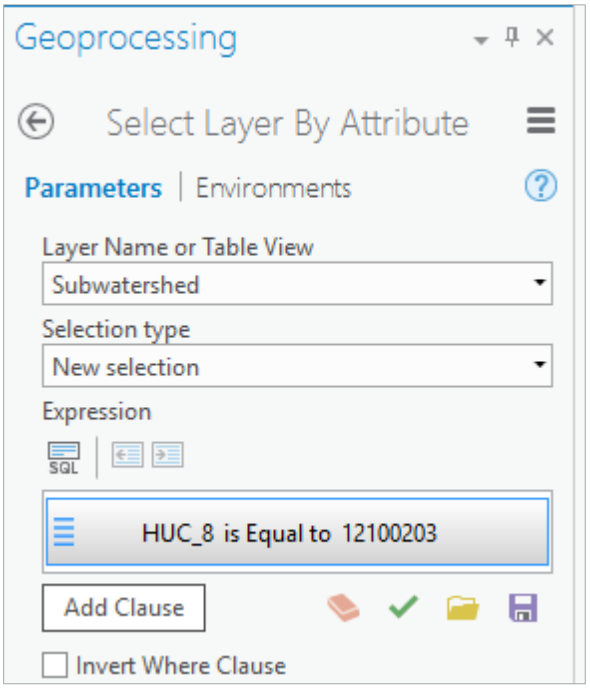
Now construct the query that will identify these records by selecting **Add Clause**



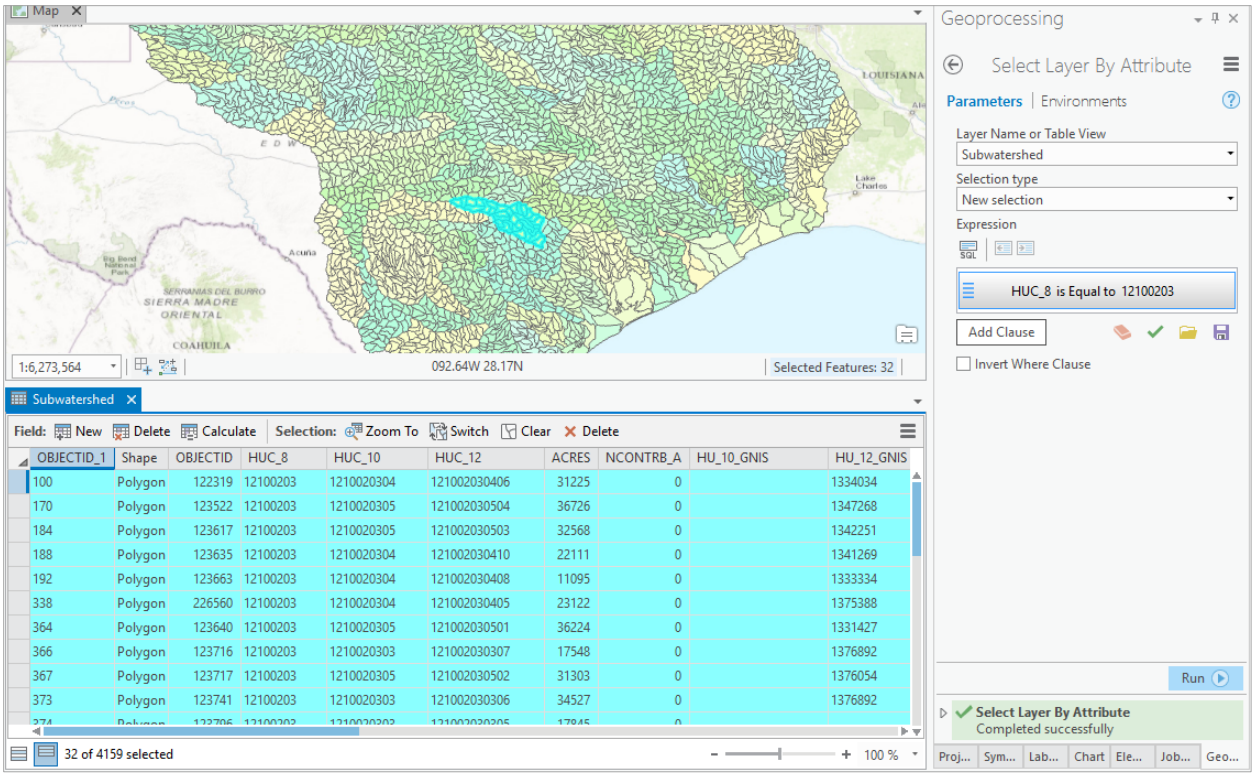
And in the resulting display choose **HUC_8 is Equal to 12100203** using the choices in the boxes available.



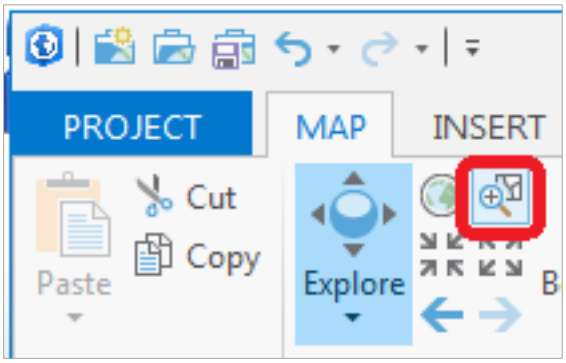
Once your clause is input, hit the **Add** button so that your expression is specified completely



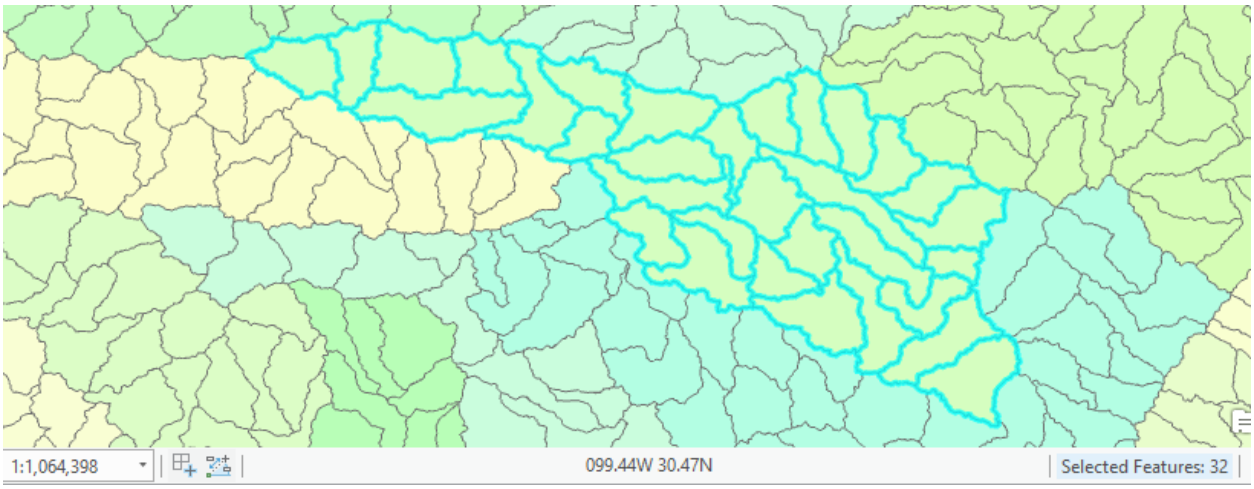
and then hit **Run** at the bottom of the **Geoprocessing** pane to select the San Marcos basin by its HUC_8 identifier. You'll see that this selects 32 of the HUC-12 Subwatersheds that lie within the San Marcos basin (one HUC-8 Subbasin). If you hit the **Selected** button at the bottom of the Table, you'll see the selected records, and also their highlighted images in the map.



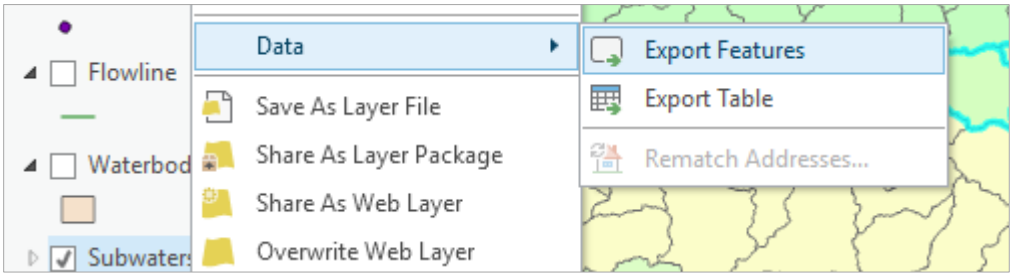
To zoom to this selection, use the **Zoom to Selected Features** button in the map tab.



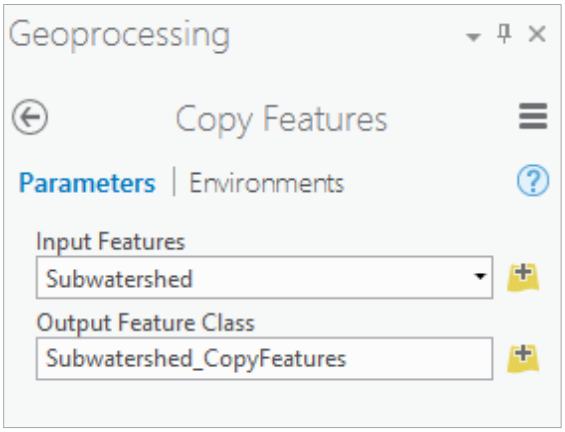
And you'll see a close up view of the San Marcos Subwatersheds.



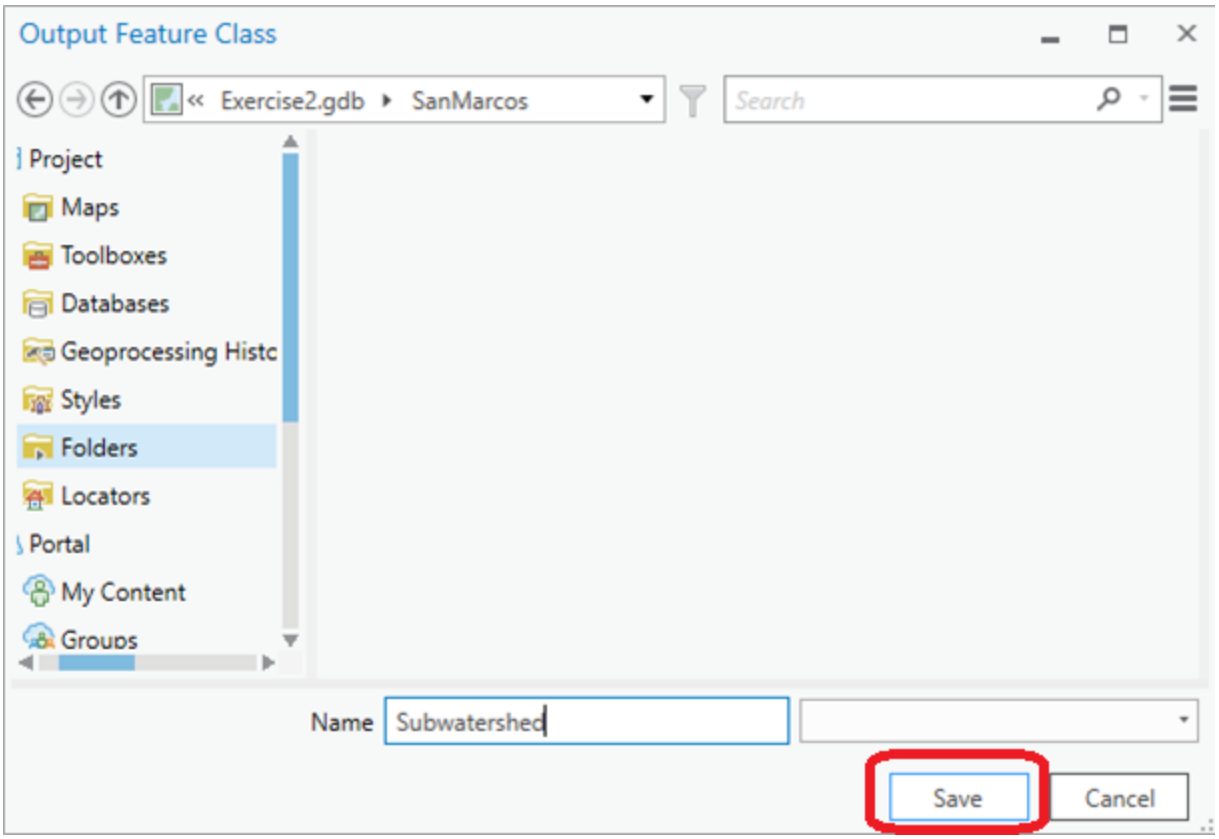
Close the **Subwatershed** attribute table to get it out of the way. Right Click on the **Subwatershed** layer and select **Data/Export Features** to produce a new Feature Class.



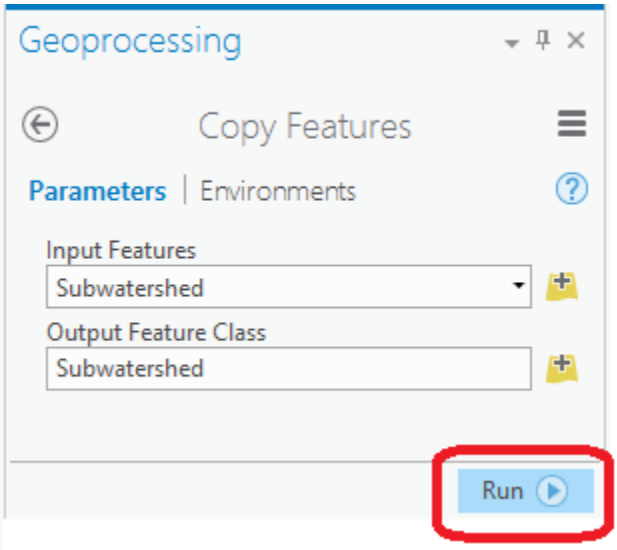
You'll see a Geoprocessing window open with Input Features as Subwatershed and Output Feature Class as Subwatershed_CopyFeatures.



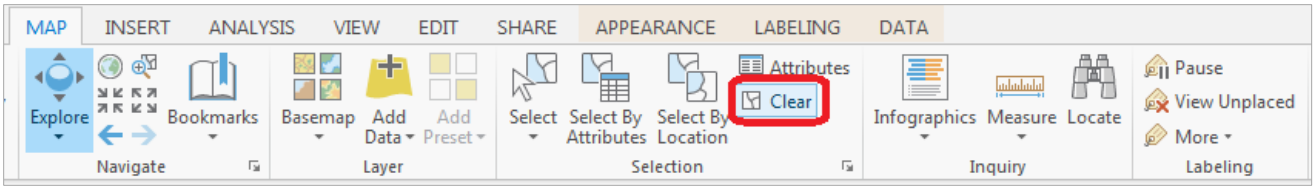
We want to place this output feature class in the SanMarcos feature dataset we created, so click on the button for the Output Feature Class and navigate to where you have stored the results in **Exercise2.gdb** in the **SanMarcos** feature dataset and call the new feature class **Subwatershed**. Click **Save**.



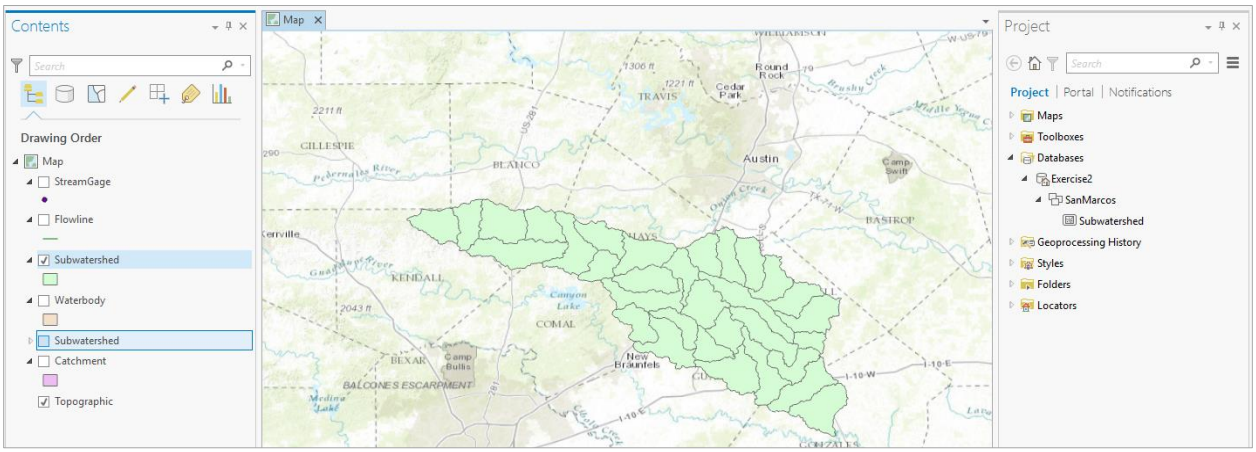
Click **Run** at the bottom of the Geoprocessing pane.



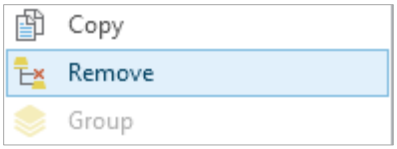
Clear the previous HUC_8 selection with the **Clear** button.



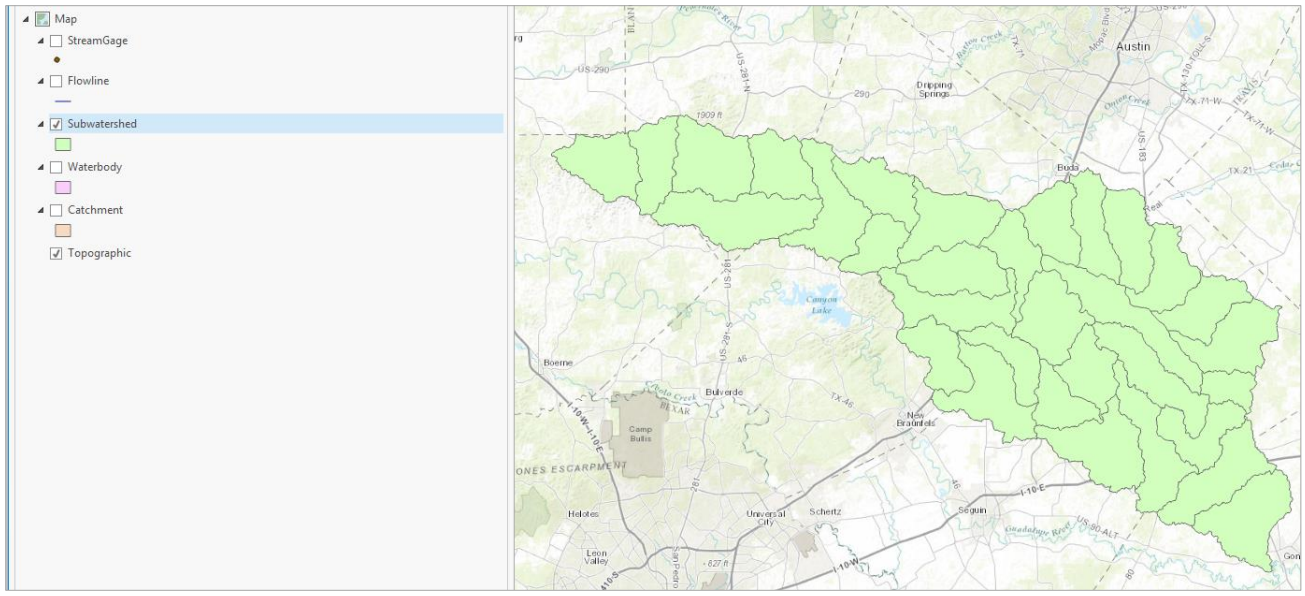
In the **Project** pane, you can navigate to the San Marcos feature dataset and you'll see there is now a Subwatershed feature class located there, and that it has been added to the Map view. Turn off the lower Subwatersheds for all of the HUC2 region, and you'll see just the Subwatersheds of the San Marcos basin. Pretty cool! We've just taken a large dataset and selected from that a smaller dataset of interest for our study.



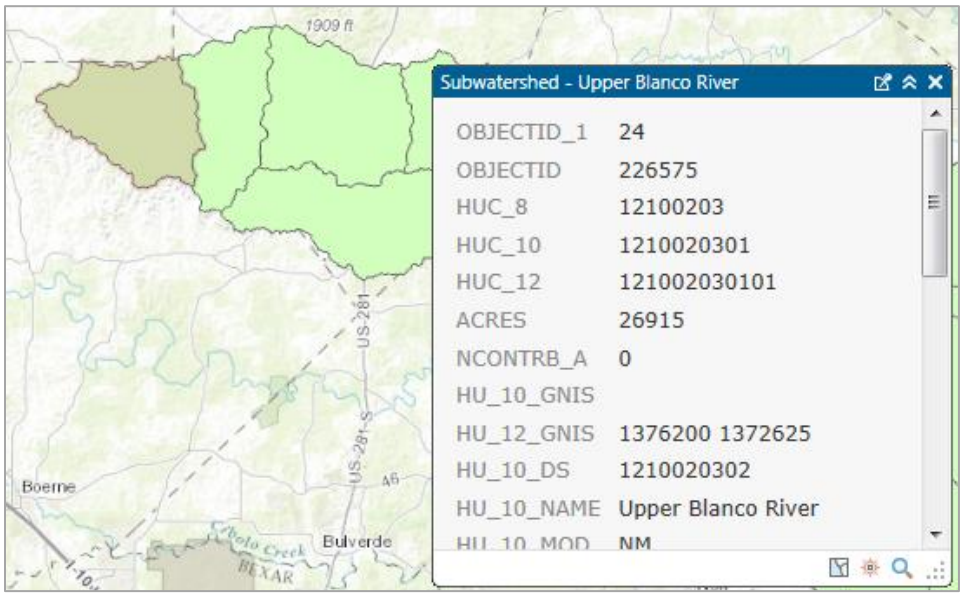
Remove the larger Subwatershed feature class for all of the Region 12 by right clicking on it and selecting **Remove**



Note that in ArcGIS there is generally a distinction between Remove and Delete. Remove is a safe action that detaches a data set from a document. Delete is a less safe action, it actually deletes the object from disk.

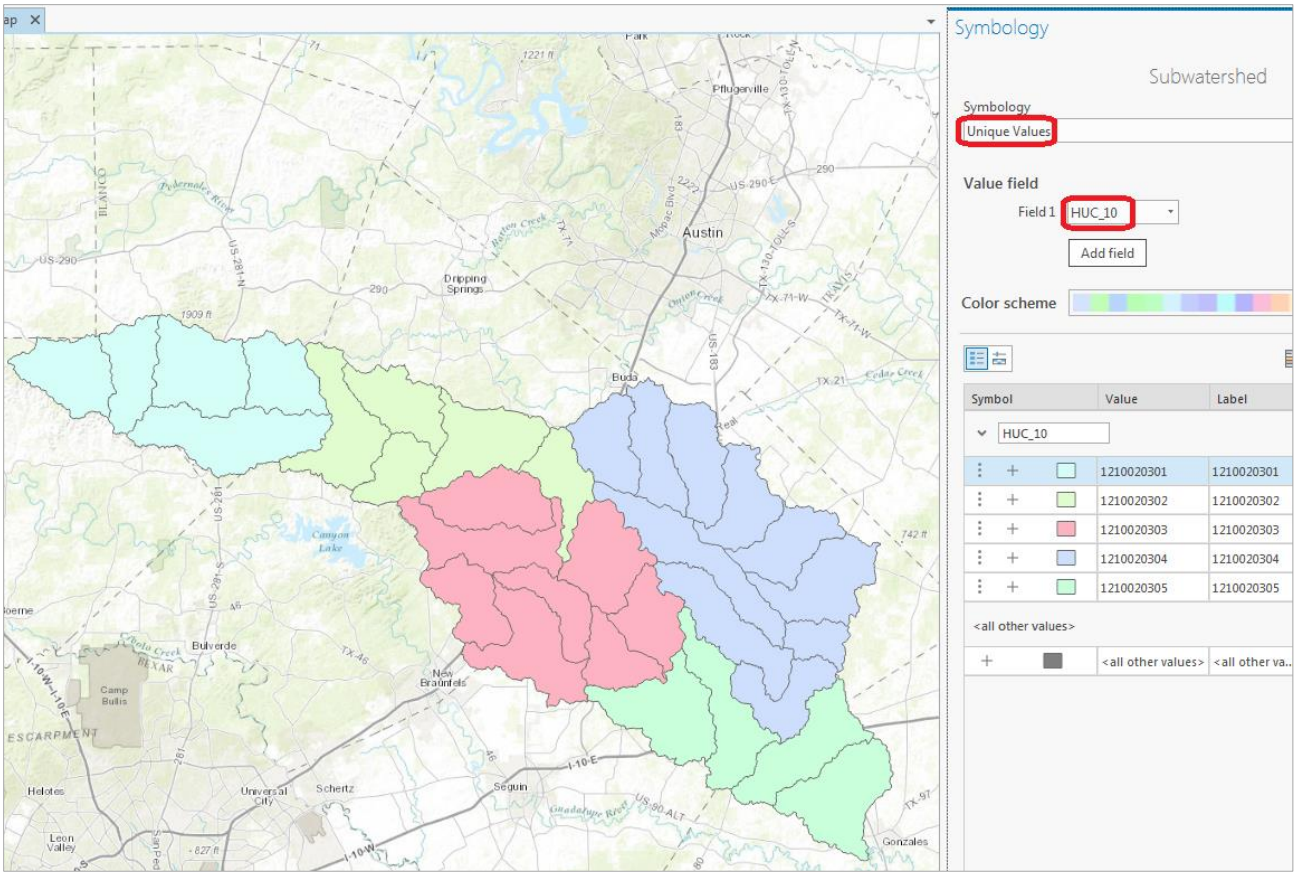


Click on the North-Western subwatershed on the map.



This is HUC_12 number **121002030101**. The position of this in the USGS drainage hierarchy is: **Region** 12, **Subregion** 10, **Basin** 02, **Subbasin** 03, **Watershed** 01, **Subwatershed** 01, thus making the HUC_8 number **12100203** as we used earlier, and the additional subdivision to the HUC_12 level yielding the 32 Subwatersheds in this Subbasin.

Right click on the **Subwatershed** feature class, and select **Symbology**. Select **Unique Values** and use **HUC_10** as the Value Field.



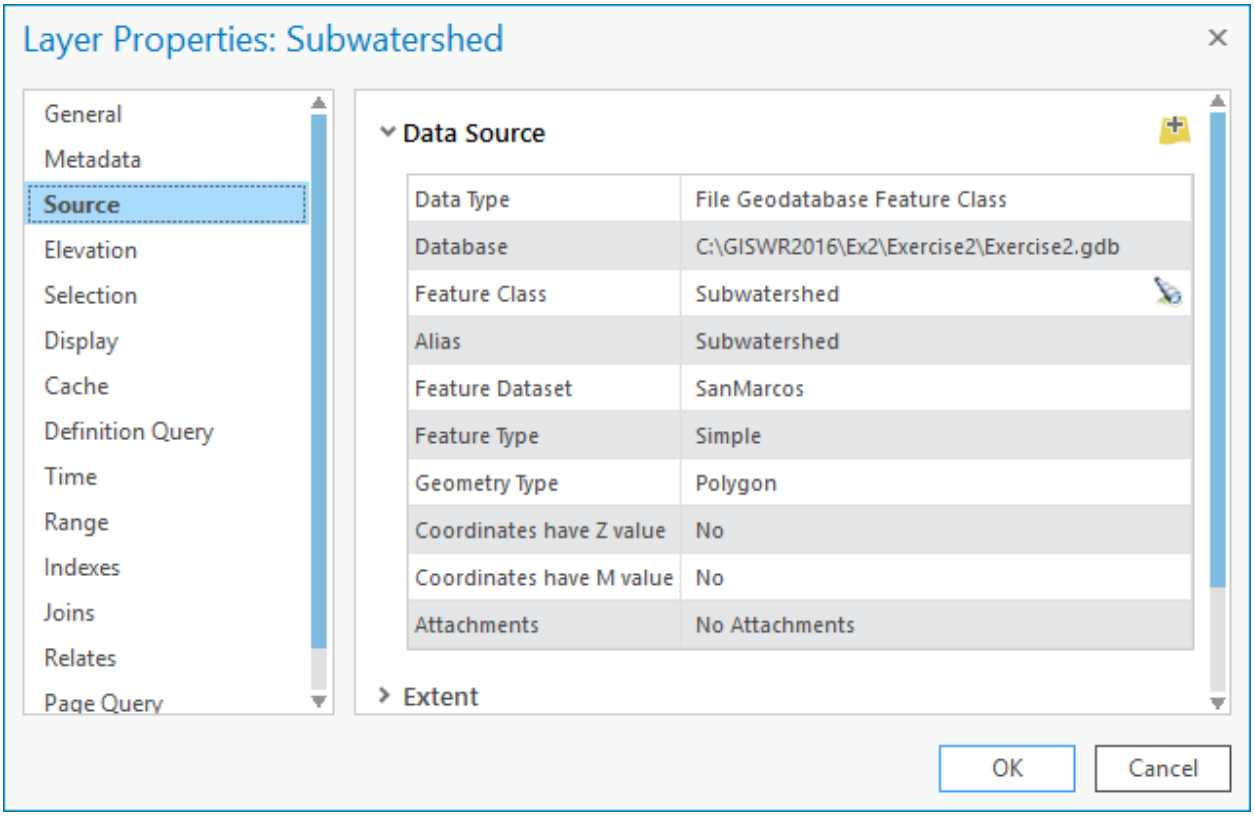
You should get this nicely colored map of the watersheds and subwatersheds of the San Marcos basin.

Notice that the 32 HUC-12 *subwatersheds* have been grouped into five *watersheds* within the San Marcos *subbasin* (I am here using the Watershed Boundary Dataset nomenclature to refer to the drainage area hierarchy in its formal sense).

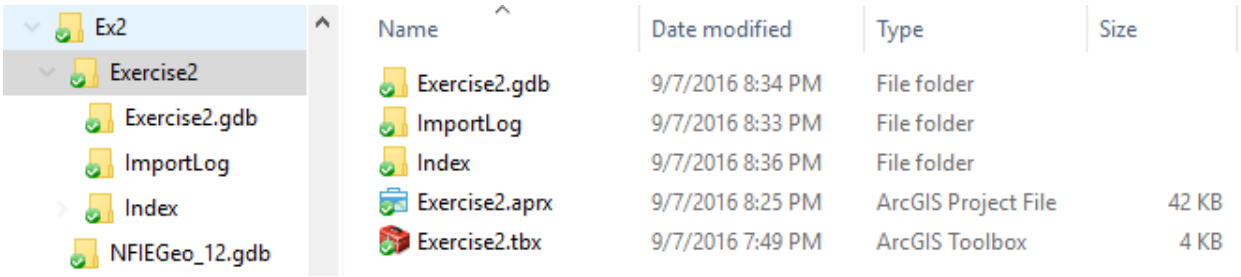
Use **Project/Save** to update your **Exercise2.aprx** map project with the new information that you've created.

Where is My Stuff?

Right click on **Subwatershed** and select **Properties** and select the **Source** tab. Notice that this Feature Class you created is in the **SanMarcos** Feature Dataset in the **Exercise2.gdb** Geodatabase in the location where you created it. It comprises Simple Features (no topology) that are Polygons (have X and Y values) but have no Z or M values, which deal with elevation and measure, respectively.



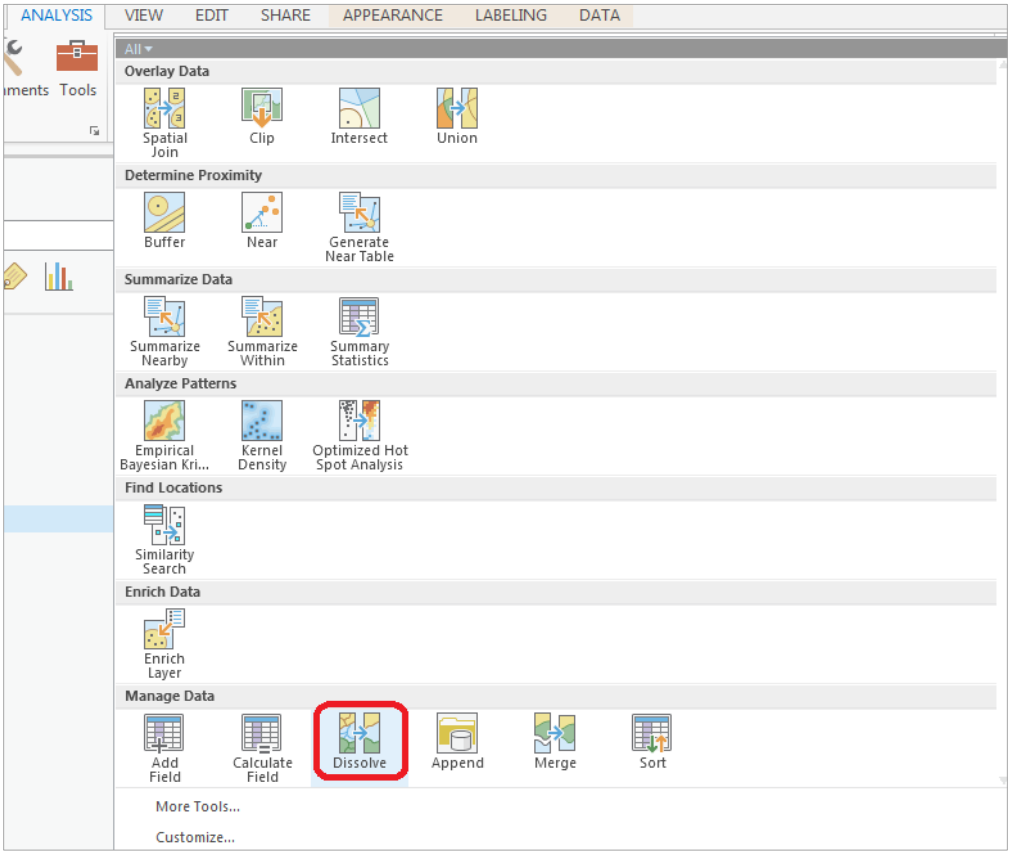
If you look at your Exercise2 folder on disk that was created when you created the project you will see a number of files, including Exercise2.gdb, which is the folder that holds this data in File Geodatabase format.



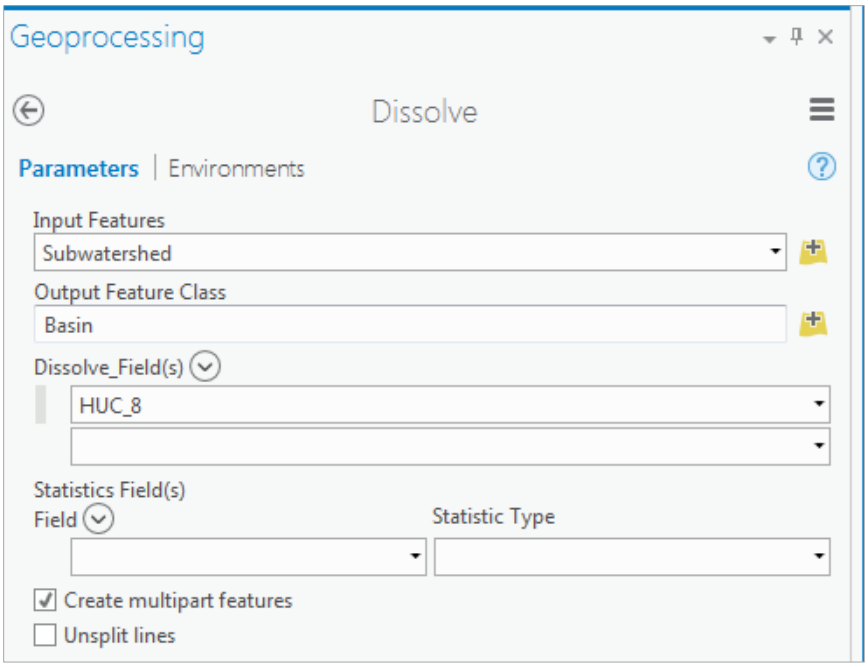
You do not need to do anything with these files, this is just pointed out to let you know where on disk your stuff is stored. Note that I had Exercise2 inside a folder Ex2 alongside the NFIEGeo_12.gdb. If you need to move these files to another computer (e.g. from the PC lab to a thumb drive) or to a different location on your computer, the integrity of the project will generally be maintained if you move all these files together retaining the relative folder structure .

Creating a San Marcos Basin Boundary

It is useful to have a single polygon for the outline of the San Marcos Basin. Navigate to the **Dissolve (Data Management)** tool in the *Analysis* tab (You have to expand the single line ribbon that you are initially presented with to get the display shown below).

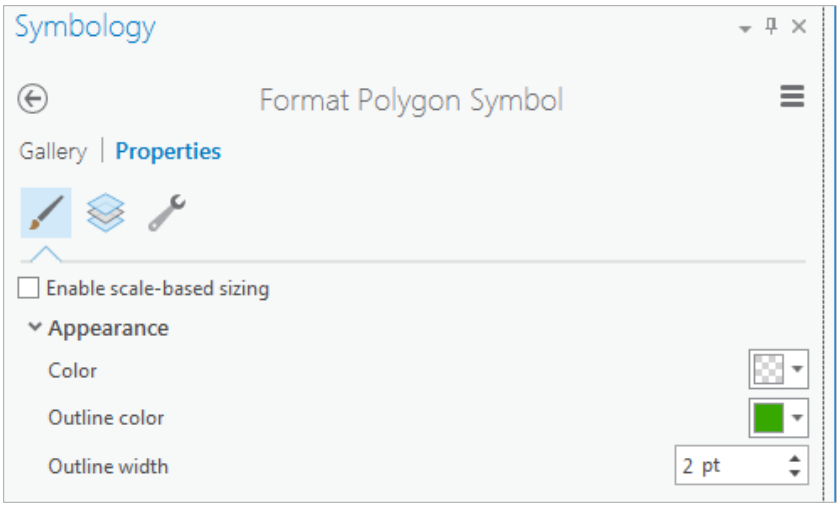


The **Geoprocessing** pane will appear with the **Dissolve** tool selected. You can drag and drop the **Subwatershed** feature class from the Table of Contents into the **Input Features** area of this window. Click on **HUC_8** as your **Dissolve_Field**. This means that all Subwatersheds with the same HUC_8 number (12100203) will be merged together. Set the output Feature class to be called **Basin** in your **SanMarcos** feature dataset. Hit **Run** to execute the function.

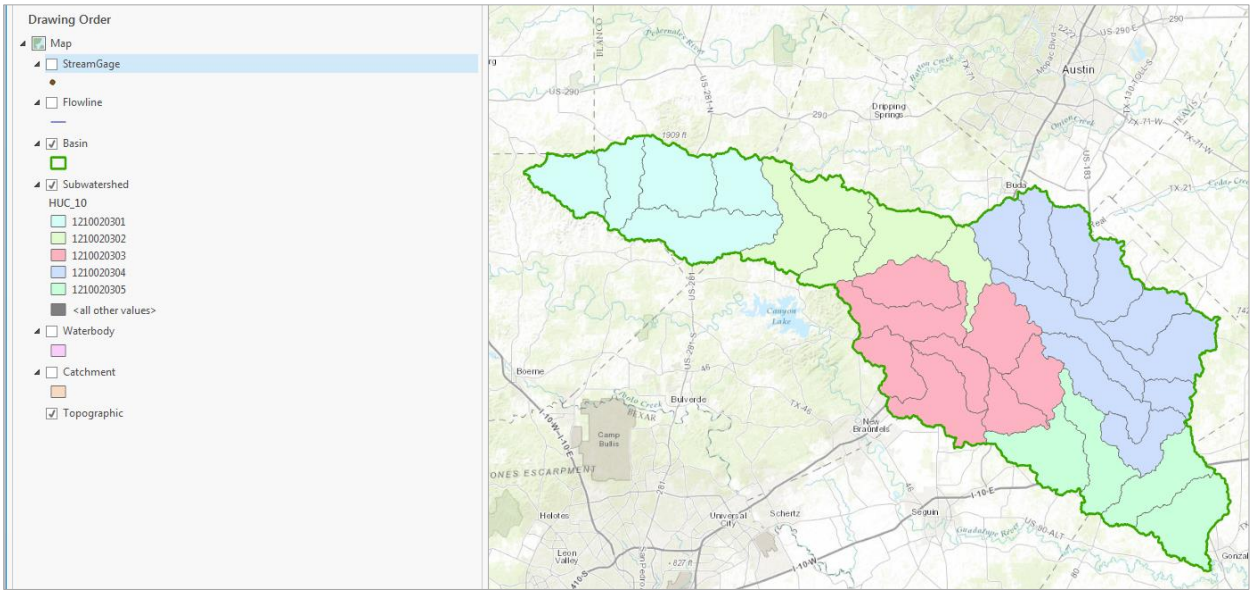


And you'll see a new Basin feature class pop up on your map display

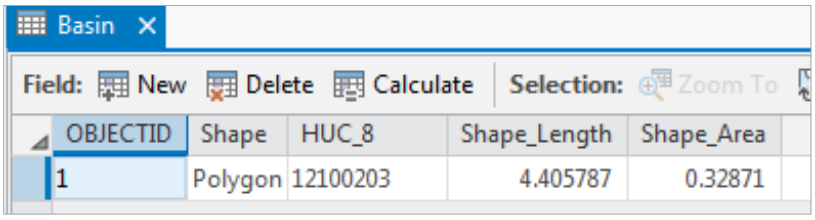
The **Basin** should appear shortly. Navigate to the **Symbology** and select **No Color** for the shape, Green for the **Outline Color** and 2 for the **Outline Width**.



You will now have a very nice looking map of the San Marcos Basin with its constituent subdrainage areas.



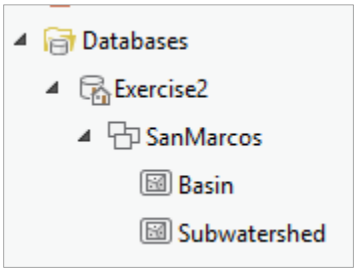
Right click on the **Basin** feature class and open its Attribute Table. Notice that the **Basin** feature class has only one Polygon and it is identified with the HUC_8 = 12100203, which is the 8-digit number all the HUC_12 subwatersheds had in common.



OBJECTID	Shape	HUC_8	Shape_Length	Shape_Area
1	Polygon	12100203	4.405787	0.32871

Use **Project/Save** to save your ArcGIS Pro project. Close the attribute table for the Basin feature class.

Navigate to your **SanMarcos** feature dataset in the **Project** pane. Notice how you've now got the **Watershed** and **Basin** feature classes that you've just created stored inside it.

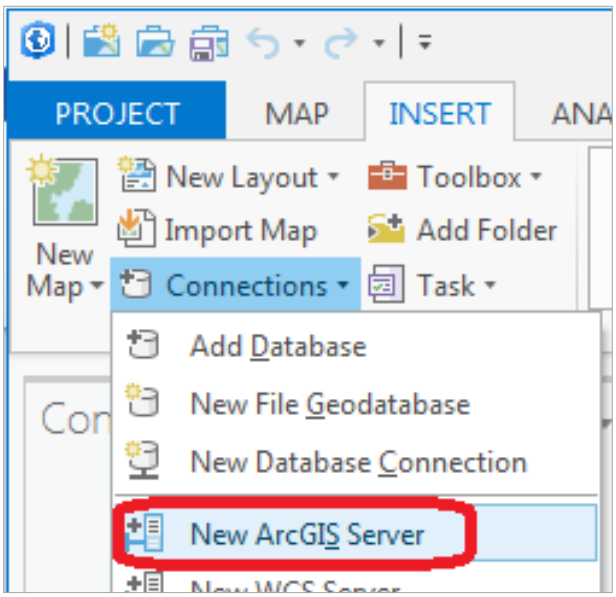


To be turned in: Make a map of the San Marcos basin with its HUC10 and HUC12 watersheds and subwatersheds. How many HUC10 and HUC12 units exist in the San Marcos Basin? Note that maps that you turn in should be clearly labeled so that they may be unambiguously interpreted with a title, scale, north arrow and appropriate legend information.

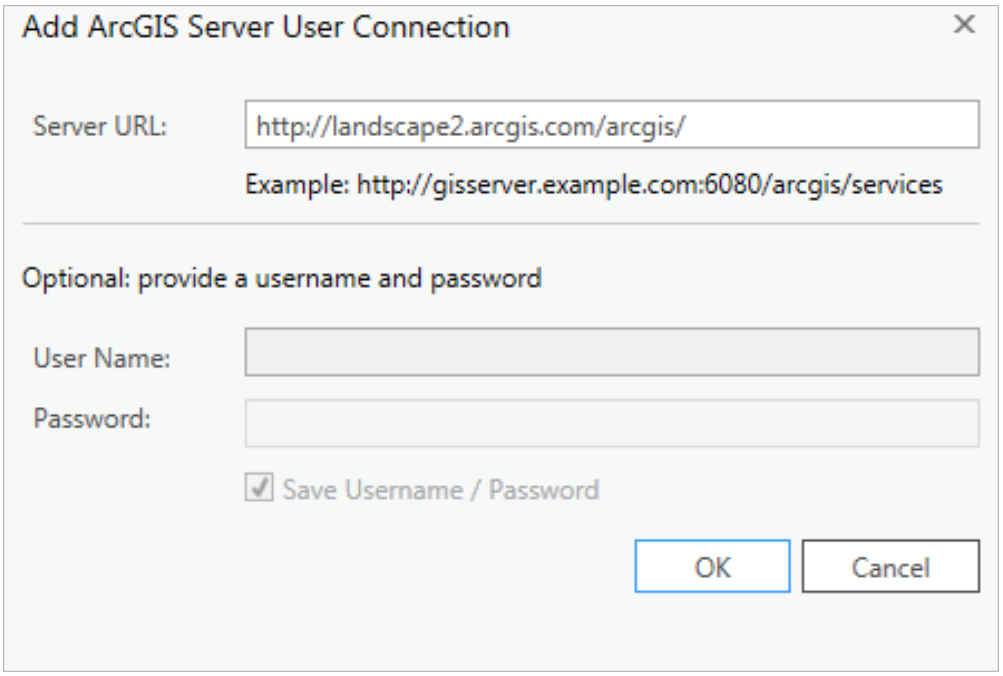
Land Cover Information for the San Marcos Basin

Now, we are going to use some of the online data services to find some land cover properties of the San Marcos basin.

Under the *Insert* tab select **Connections/New ArcGIS Server**.

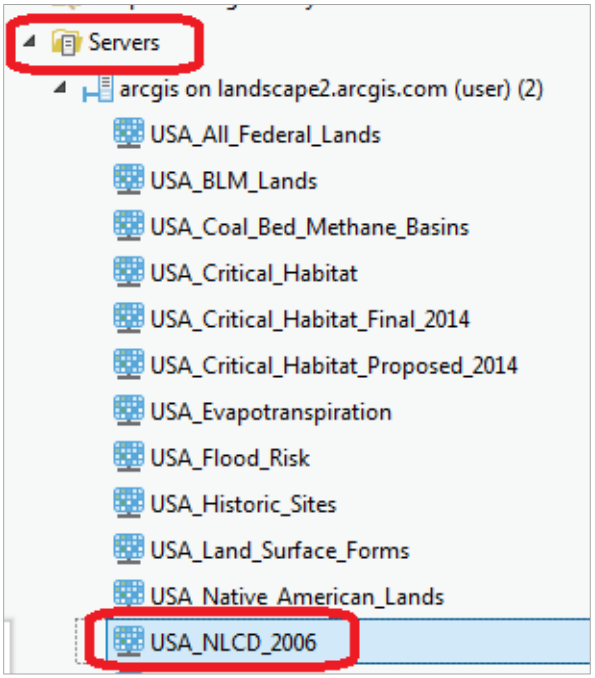


Add the following URL: http://landscape2.arcgis.com/arcgis/

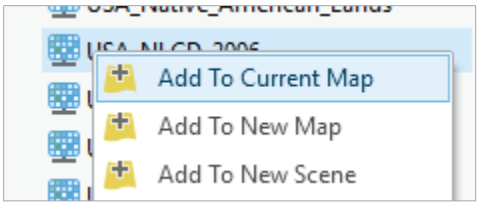


Note that if you are already signed in, the User Name and Password sections will be greyed out when you click on them. If they do not grey out, make sure to fill in both sections with your ArcGIS Online credentials before pressing OK.

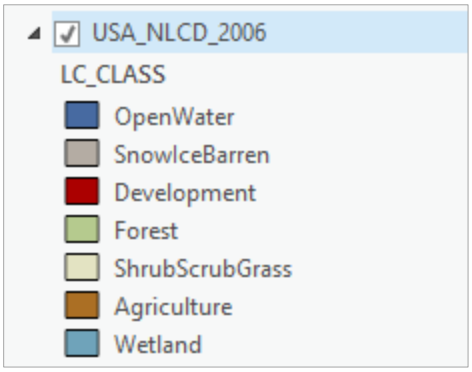
Navigate to **USA_NLCD_2006** in the **Project** pane under the **Servers** folder. This is the USGS Land Cover raster map of the United States.

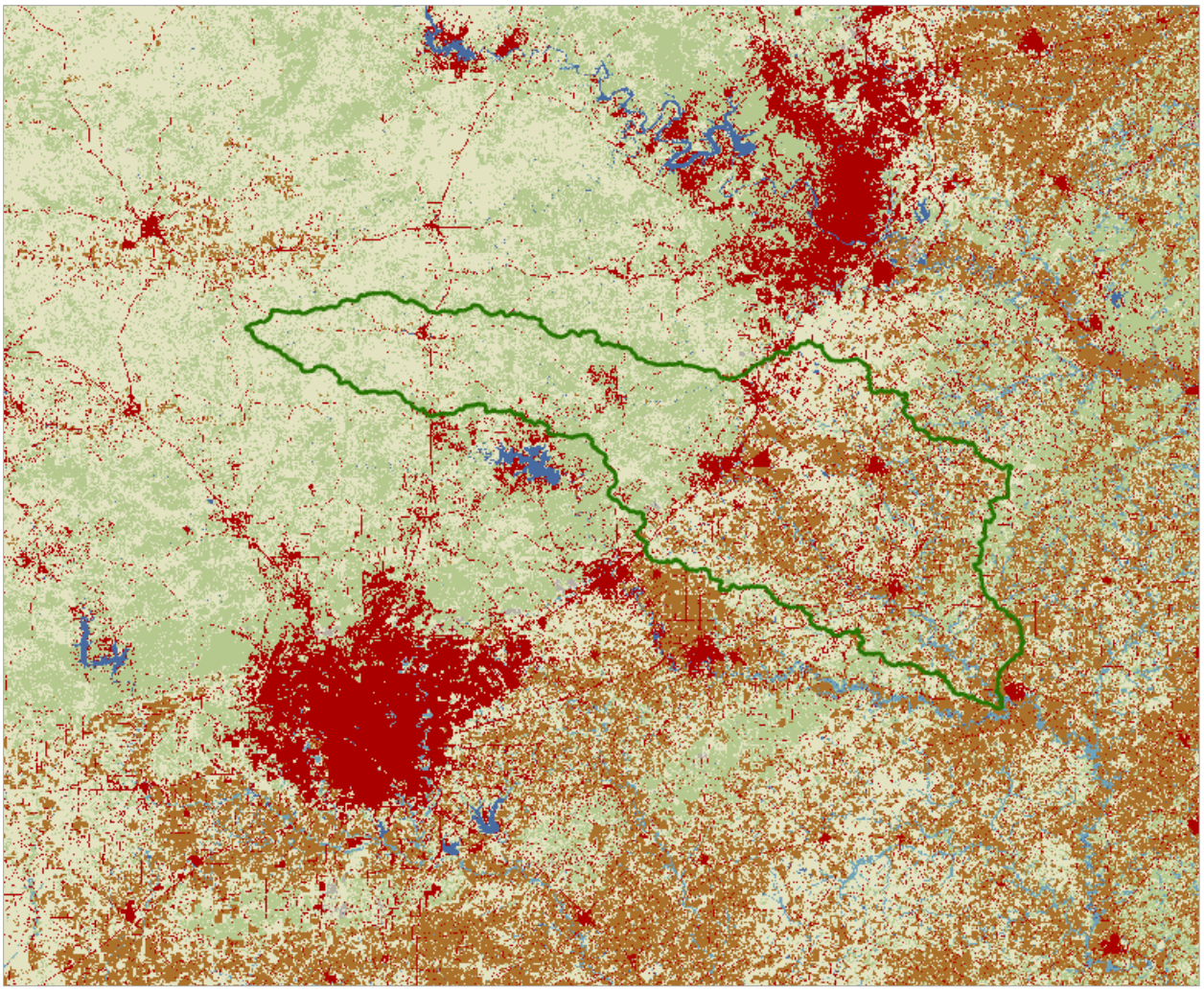


Right Click on this and add it to your current map



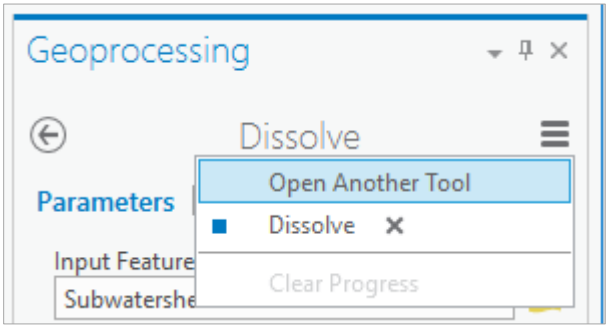
and you'll see it shows up with predetermined color scheme that highlights urban areas in red. In the Table of Contents click off the **Subwatershed** layer, so that you only have the **Basin** displayed over the land cover data. San Antonio is towards the bottom of the map, Austin near the top, and San Marcos lies within the basin. Notice also the profusion of brown for Agriculture on the right-hand side of the map, to the east of the Balcones escarpment.



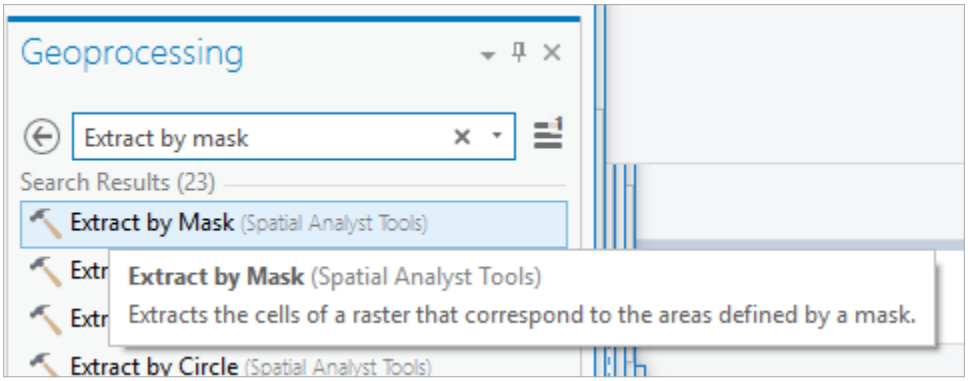


Use **Project/Save** to save the current map display

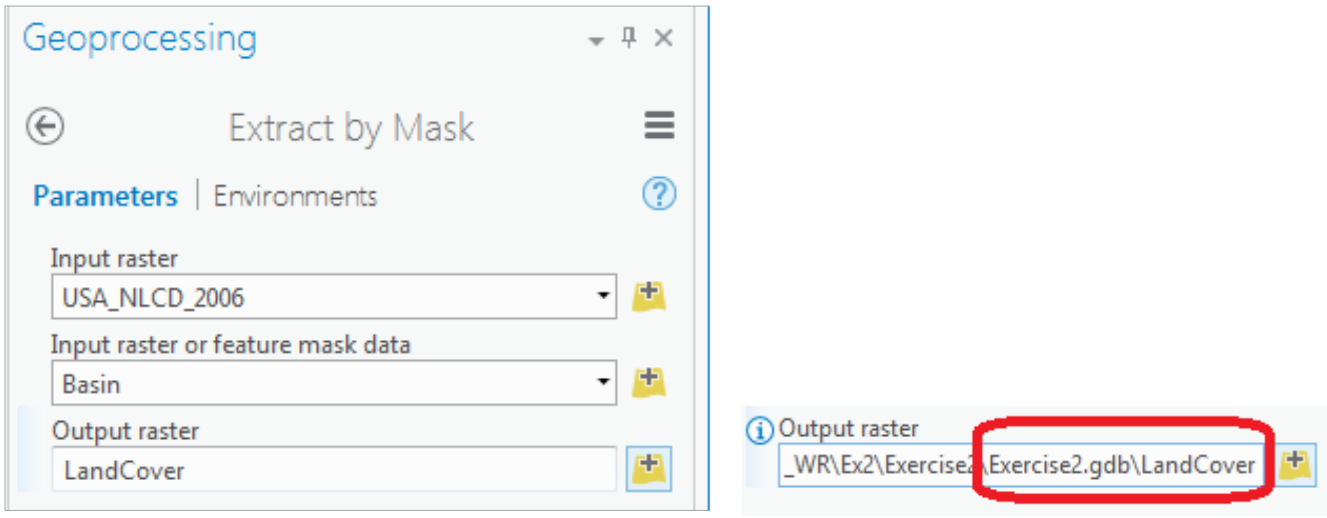
In the Geoprocessing pane, in the top right hand corner, select **Open Another Tool**



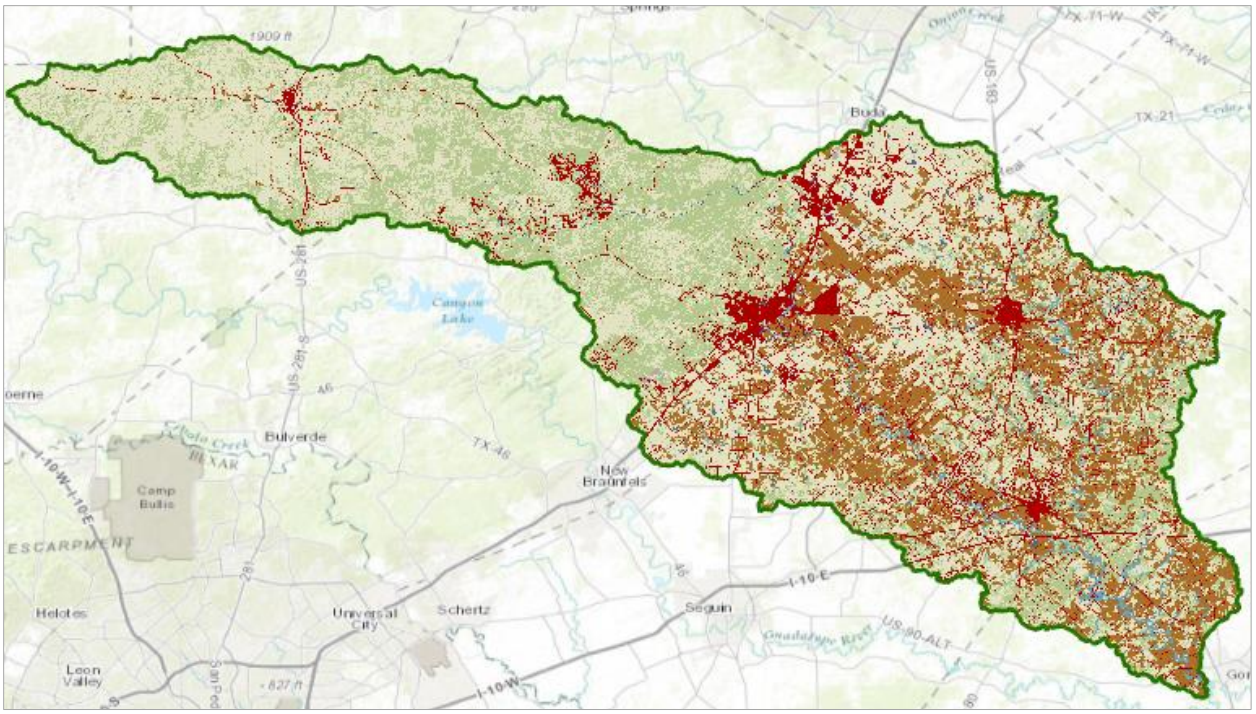
And search for **Extract by Mask** from the Spatial Analyst Tools



Click on the **Extract by Mask** tool, and use **USA_NLCD_2006** as the Input Raster and **Basin** as the mask data; put the result in the **Exercise2** geodatabase with the name **LandCover**. Be careful to store the Output raster directly inside the Exercise2.gdb, not inside the **SanMarcos** Feature Dataset, which only stores vector feature classes.

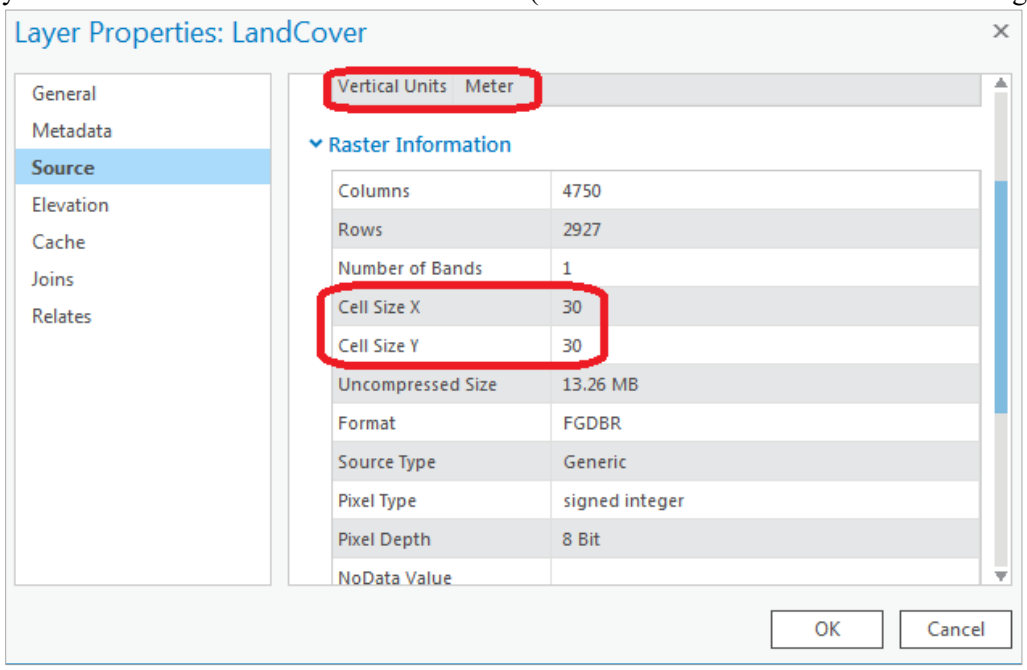


After a while you'll see the result appear in the Map using the same symbology as the original service. Very cool! Turn off the original NLCD service to highlight your new dataset.



The contrast between the forest to the west of the Balcones fault zone and agriculture to the east is now particularly clear, as are the urban areas lying along the IH-35 corridor between Austin and San Antonio.

If you right click on the LandCover raster and open its **Properties**, and then select **Raster Information**, you'll see it is a raster with 30m x 30m cells (these are derived from 30m Landsat imagery).



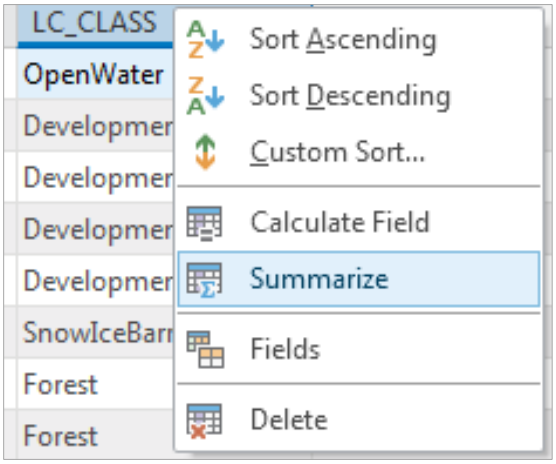
Because this is an integer grid, it has a Value Attribute Table (grids with real numbers do not have a VAT). Open the **Attribute Table** and you'll see the land cover classes indicated by **Value**. The **Count** indicates the number of cells having that Value.

LandCover

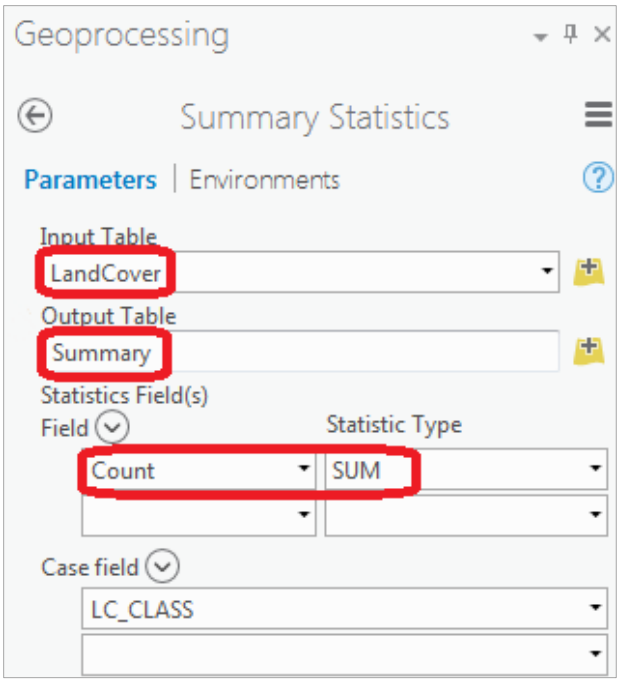
Field: New Delete Calculate | Selection: Zoom To Switch Clear Delete

OBJECTID_1	OBJECTID	Value	Red	Green	Blue	Opacity	Count	LC_CLASS
1	2	11	0.28	0.42	0.63	1	22455	OpenWater
3	4	21	0.87	0.79	0.79	1	409845	Development
4	5	22	0.85	0.58	0.51	1	42787	Development
5	6	23	0.93	0	0	1	20018	Development
6	7	24	0.67	0	0	1	9046	Development
7	8	31	0.7	0.68	0.64	1	8890	SnowIceBarren
8	9	41	0.41	0.67	0.39	1	579051	Forest
9	10	42	0.11	0.39	0.19	1	728157	Forest
10	11	43	0.71	0.79	0.56	1	43039	Forest
11	12	52	0.8	0.73	0.49	1	1641142	ShrubScrubGrass
12	13	71	0.89	0.89	0.76	1	603736	ShrubScrubGrass
13	14	81	0.86	0.85	0.24	1	698328	Agriculture
14	15	82	0.67	0.44	0.16	1	303988	Agriculture
15	16	90	0.73	0.85	0.92	1	106772	Wetland
16	17	95	0.44	0.64	0.73	1	2679	Wetland

Right click on **LC_Class** and select **Summarize**.

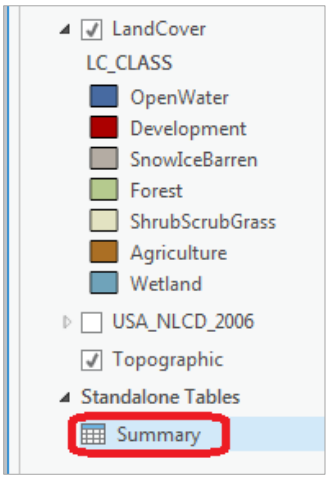


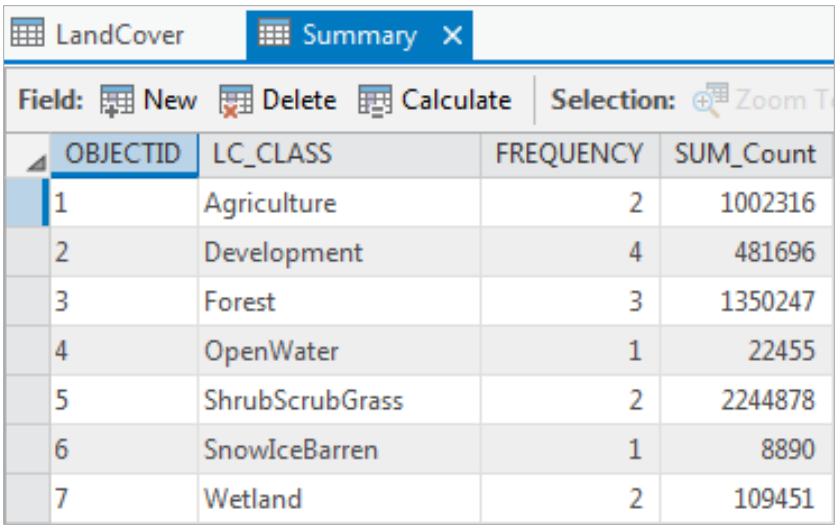
In the **Field** section select **Count** with a Statistic Type **SUM**, then save the result as a table called **Summary** in the **Exercise2** geodatabase (not in the SanMarcos feature dataset).



Click **Run**.

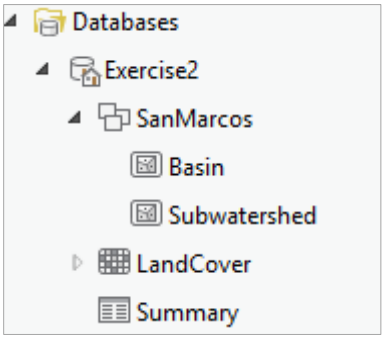
The computation will proceed and add the Summary table to your Map document. Open it and you'll see a Summary of the land cover distribution of the San Marcos basin, as given by the count of the number of cells having each land cover type.





OBJECTID	LC_CLASS	FREQUENCY	SUM_Count
1	Agriculture	2	1002316
2	Development	4	481696
3	Forest	3	1350247
4	OpenWater	1	22455
5	ShrubScrubGrass	2	2244878
6	SnowIceBarren	1	8890
7	Wetland	2	109451

If you use the Project pane to navigate to Databases, you'll see that you have a new Summary table in your geodatabase, along with the LandCover raster created earlier:



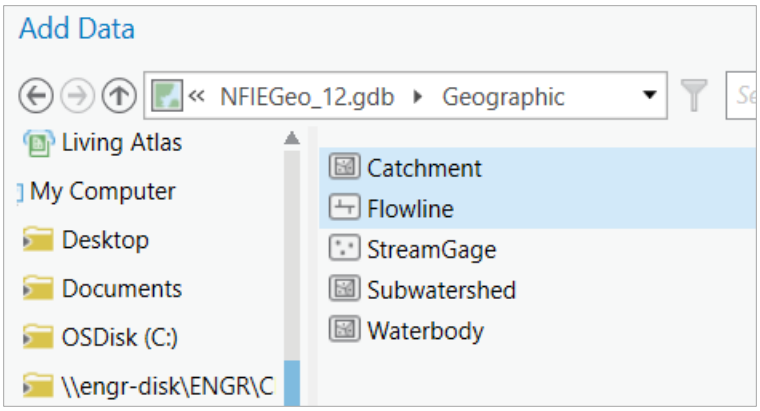
Use **Project/Save** to save your project file.

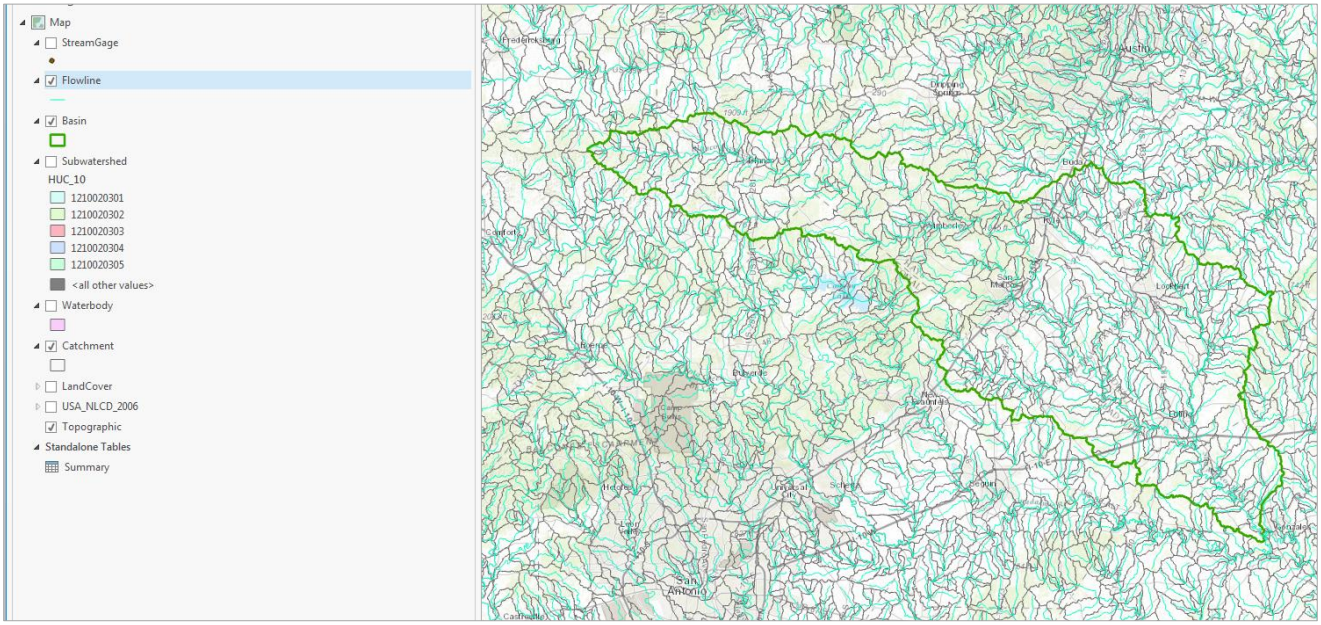
The count of the number of grid cells in this table, can be used with cell size to determine the area in each land cover class.

To be turned in Make a map of the land cover variation over the San Marcos Basin. Prepare a table that shows the area (km^2) of each of the seven main land cover classes and the % of the total basin area that each represents.

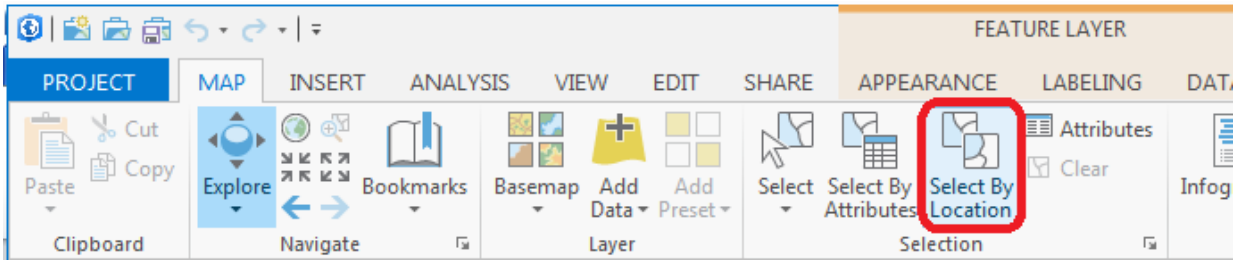
Obtaining the San Marcos Flowlines and Catchments

Go back to the data from **NFIEGeo_12.gdb** that you downloaded at the beginning of the exercise and focus on the **Flowlines** and **Catchment** to your Map display, and turn off the LandCover distribution. If necessary, reload the Flowlines and Catchment from the geodatabase to the map display. Color your Catchments as "No Color" with a green outline, and your Flowlines as nice blue streams using the same procedure as before of Right Clicking on the feature class name and selecting Symbology from the choices then available to you.

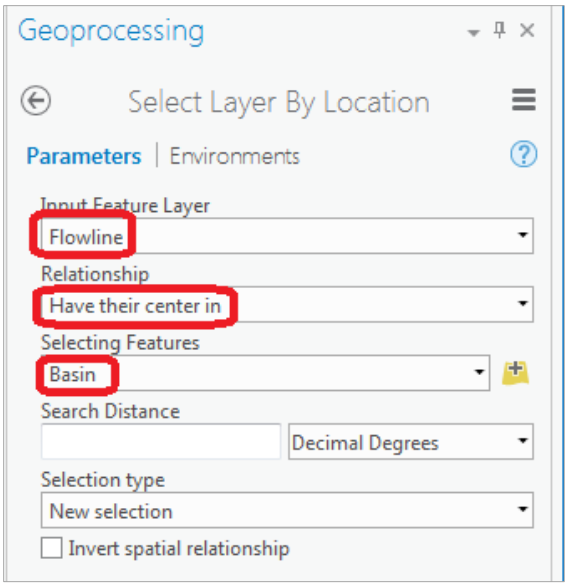


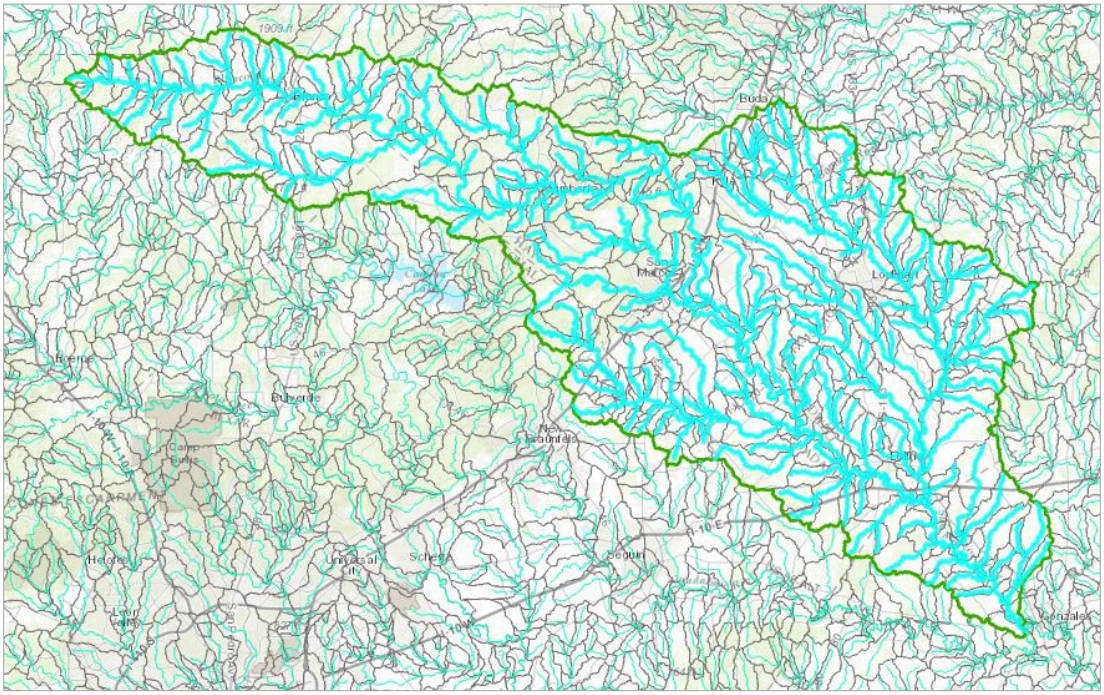


Now, let's select the features from our large dataset that lie within our Basin. Click the **Selection by Location** button on the *Map* tab.

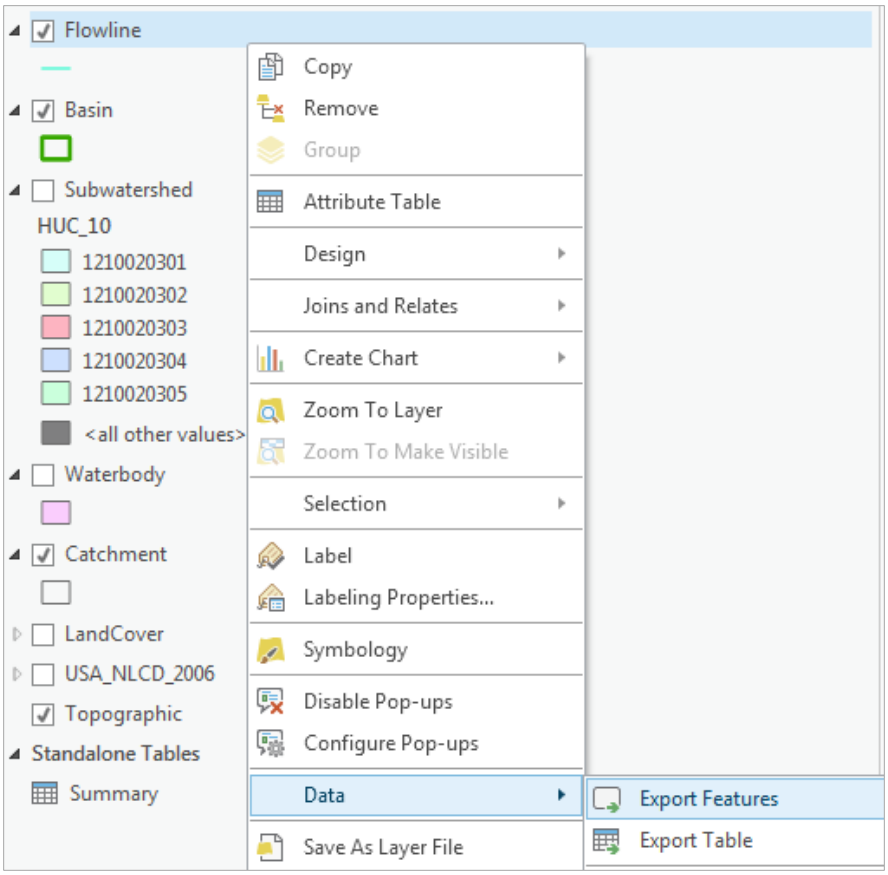


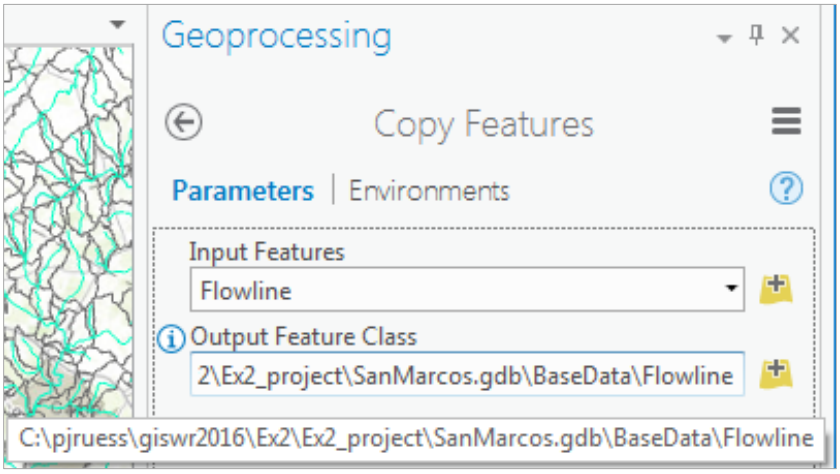
Select the features from the **Flowline** feature class that **Have their center in** the **Basin** and you'll see these flowlines selected as shown below.



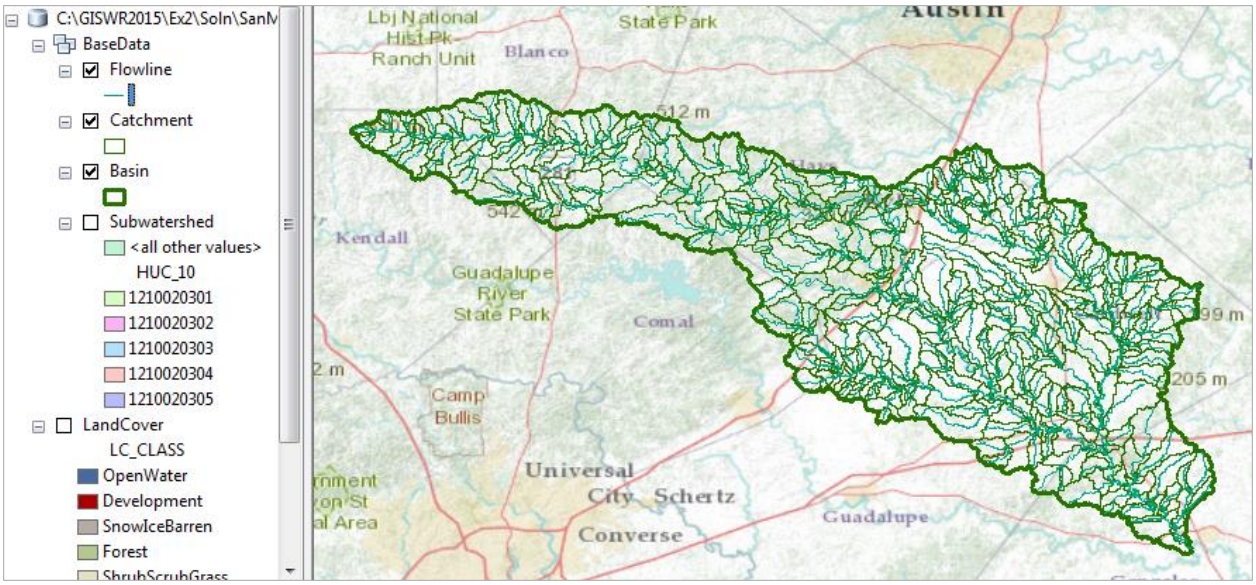


Export these selected Flowlines to a feature class called **Flowline** in the SanMarcos geodatabase, and add it to your Map display.

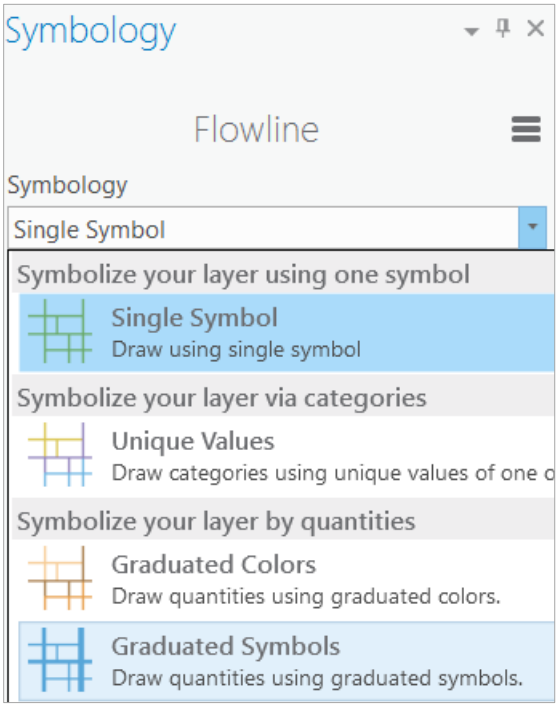


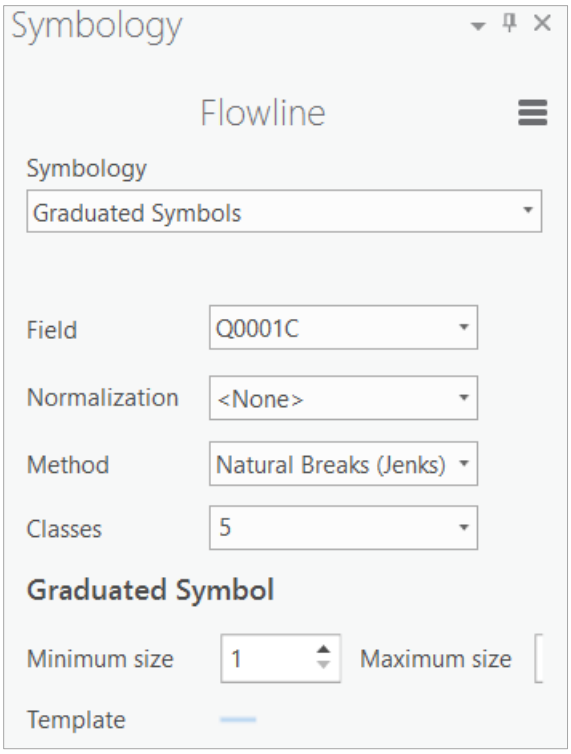


Remove the original Flowline feature class for Region 12 from your map display.



This map looks a little bit like spaghetti, so let's recolor the Flowlines according to the Mean Annual Flow (Q0001C attribute). Right click on the **Flowline** feature class and select **Symbology**. Use **Graduated Symbols** with **Field Q0001C** and click on **Template** to change the base color to blue.

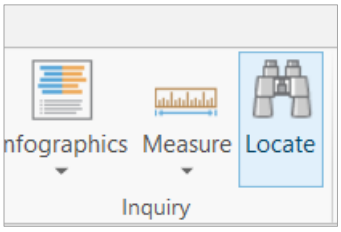


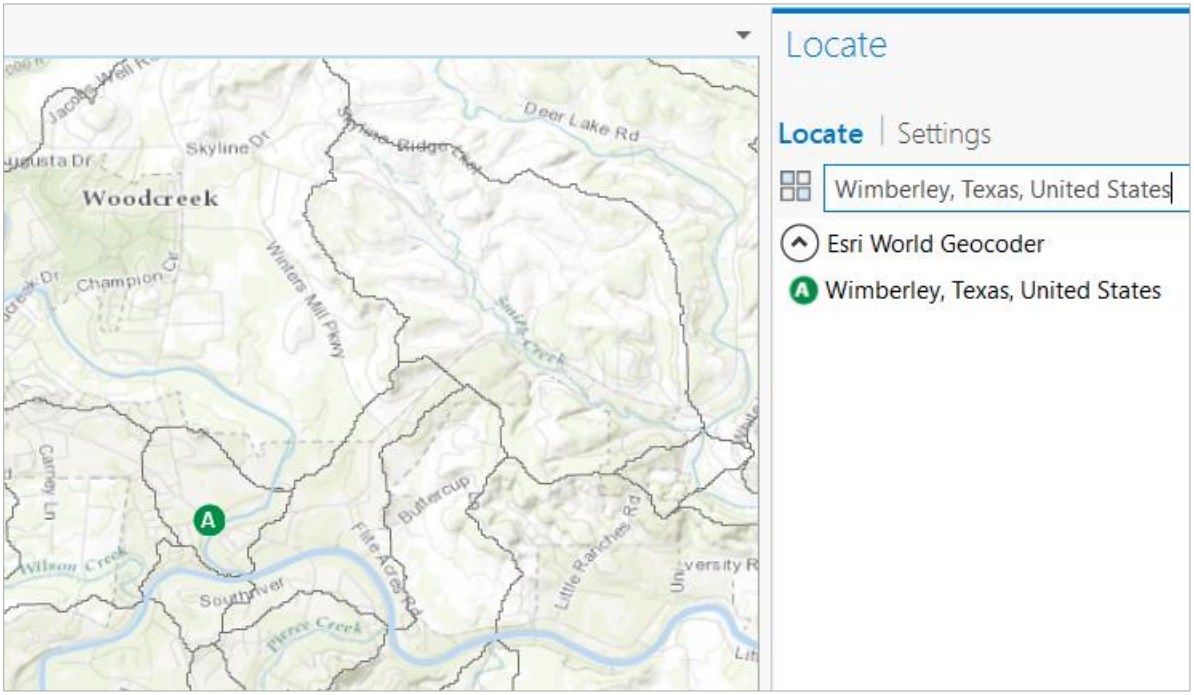


Click **Apply**.

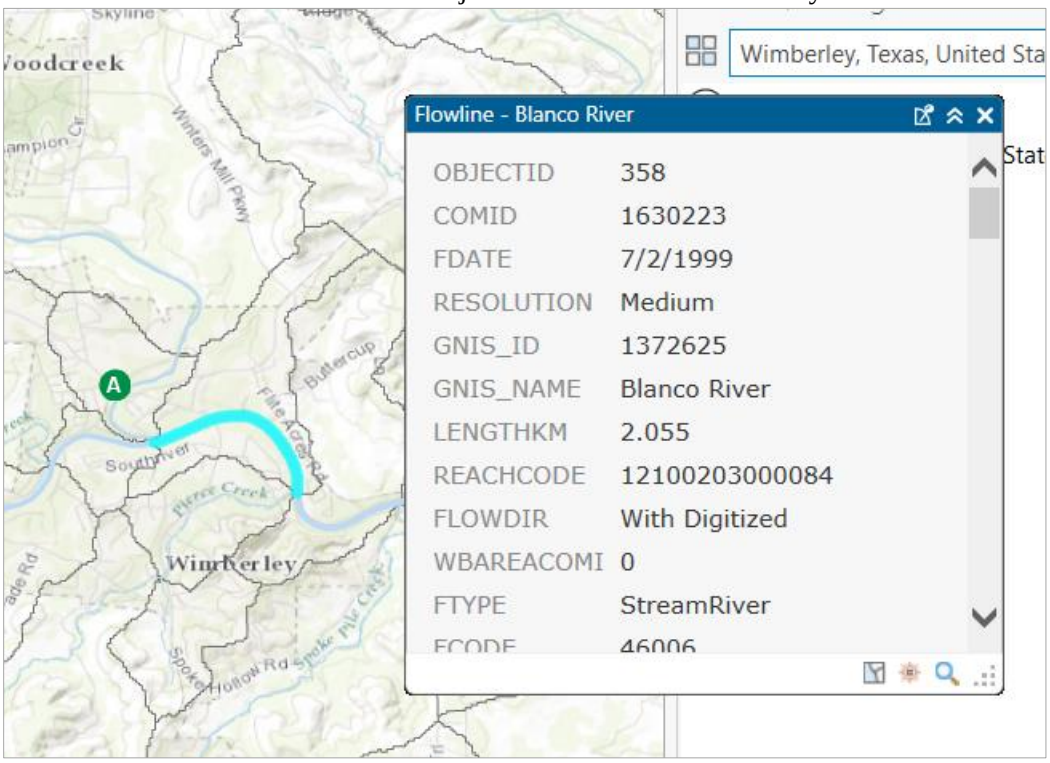
Turn off the Catchments and you'll get a nice display of the distribution of the streams and rivers in the San Marcos Basin

Repeat the same process with **Catchment** as you did for **Flowline:** (1) Use Select by Location to select those catchments having their center in the San Marcos basin; (2) Export those catchments to the San Marcos feature dataset as a new feature class; (3) Remove the larger Region 12 catchment set from the map display and recolor the San Marcos catchments appropriately as a backdrop to your selected flowline set.

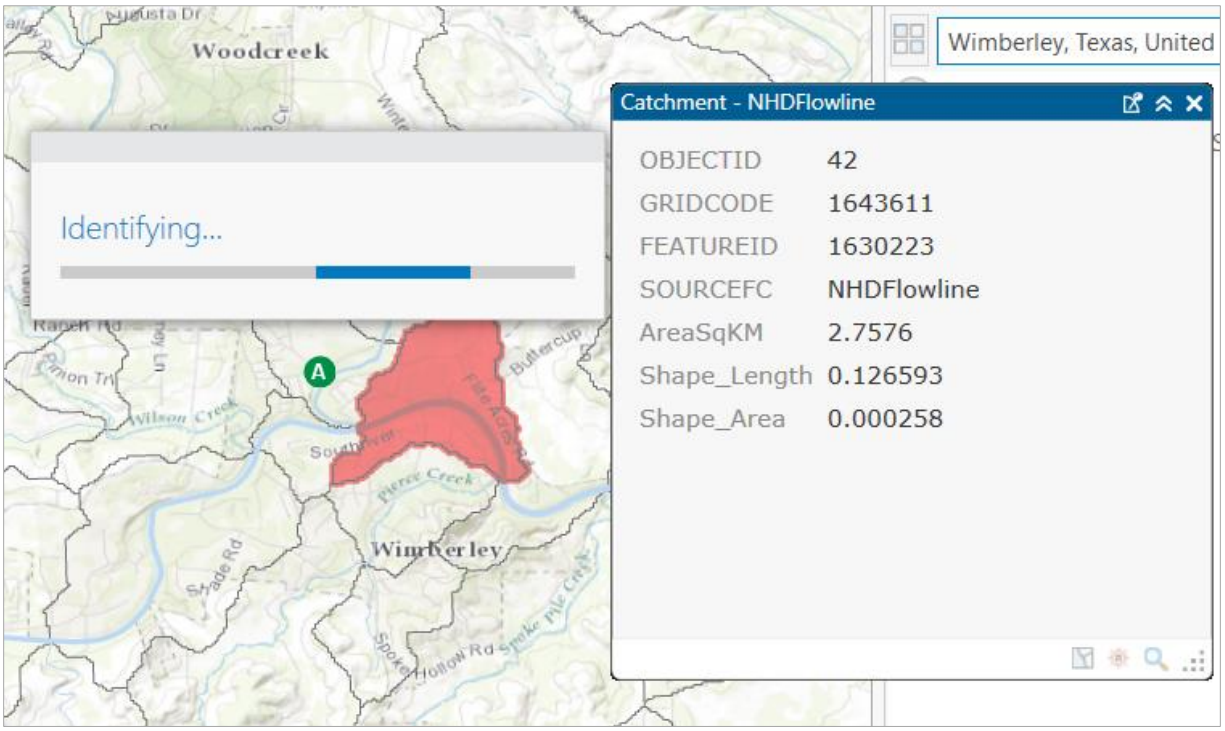
Use the Locate button in the Map view  to locate the town of Wimberley, Texas



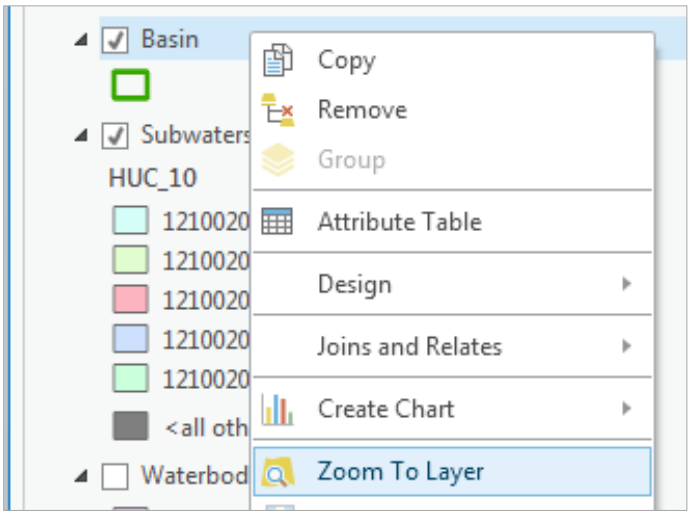
Click on the reach of the Blanco River just downstream of Wimberley:



And you'll see that this reach has a **COMID = 1630223**. We'll use this later to get information from the National Water Model. If you click on the catchment within which this flowline is located, you'll see that it has a **FeatureID = 1630223**. It is this one to one relationship between the COMID of the Flowline and the FeatureID of the Catchment that connects the river and stream segments with their surrounding local drainage areas in the National Water Model.



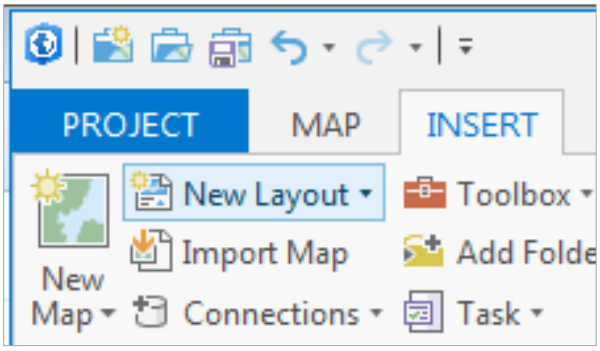
Use **Zoom to Layer** for the **Basin** feature class to get back the original extent of our map.



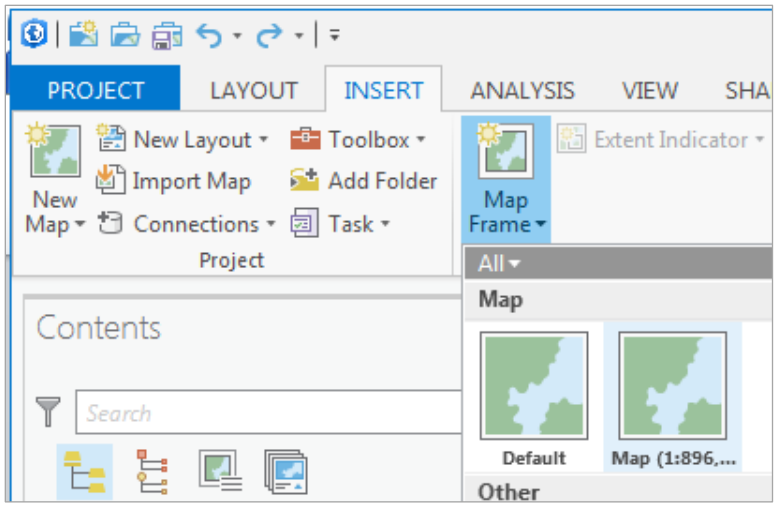
Turn off the Locate panel to eliminate the symbolization of Wimberley.

Explore the map and identify where the Blanco River, San Marcos River and Plum Creek are located in the basin.

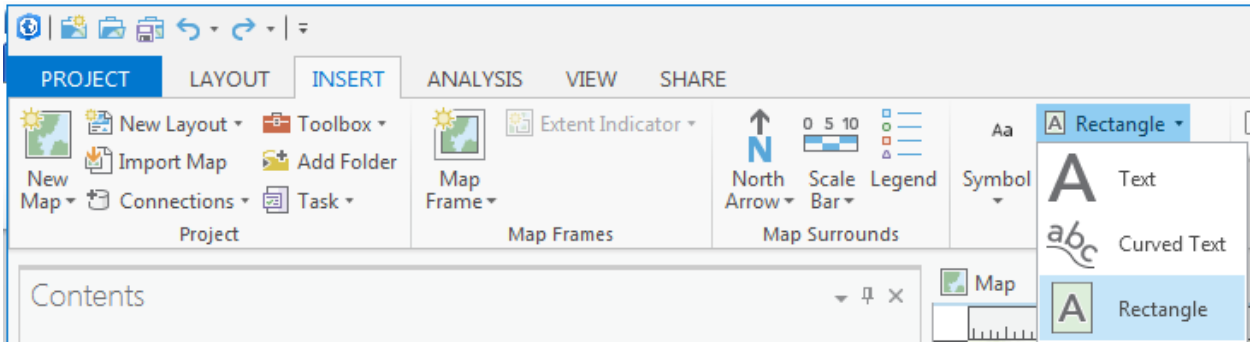
Now let's create a map and do some summarization of watershed attributes. We'll need to create a new Layout with the **New Layout** button in the *Insert* tab.



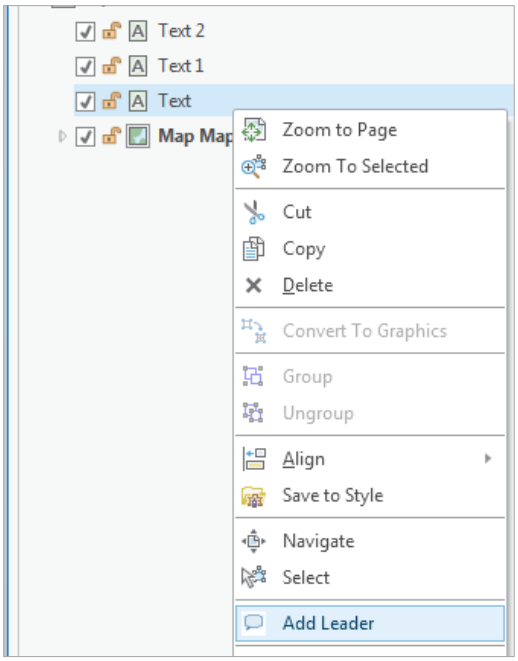
Add your **Map Frame** to the **Layout** (make sure you can see the whole basin),



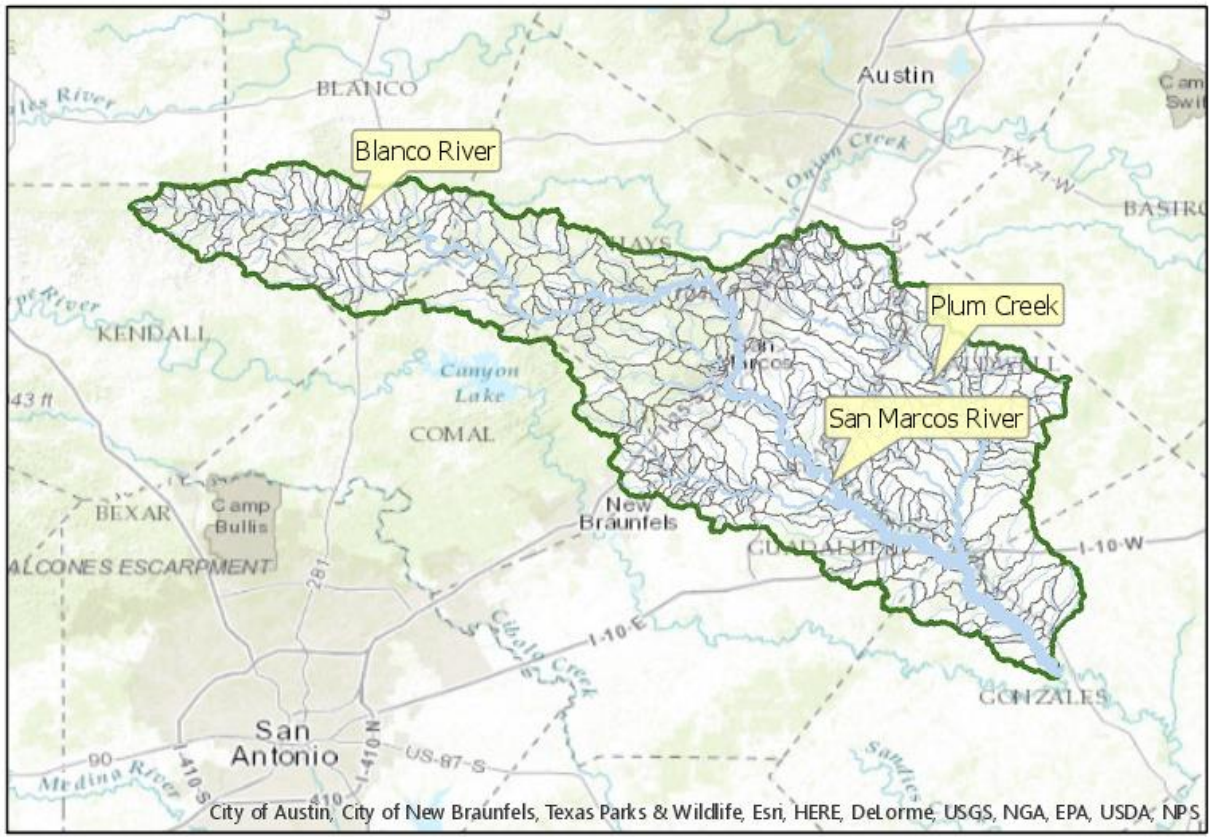
add a **Text Rectangle**,



Add **Plum Creek**, **Blanco River**, and **San Marcos River** Text Rectangles to the **Layout** (click on the tool and then draw a box on the map and type in the river name. , then right-click on each Text Rectangle in the **Contents** pane and select **Add Leader**.

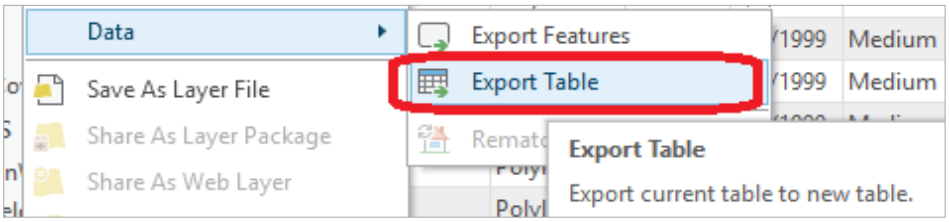


Move the Text Rectangles around and select **Add Leader** again to change the location of the pointer until your map looks something like this:

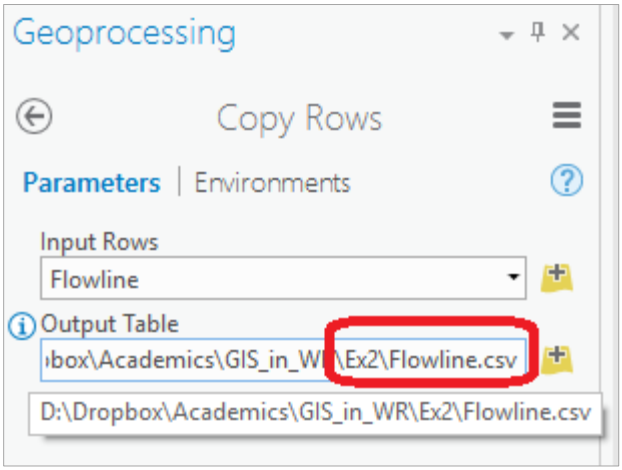


Save your map document as **Ex2_project_flow.aprx** to preserve your layout.

Open the attribute table for Flowline. Note that there is a field **LENGTHKM** that was obtained from the original data. Use this to compute the average length of flowlines. This is easiest done in Excel. Right click on Flowline and select Data Export Table.



Set the output to Flowline.csv, being careful to locate this outside a geodatabase.



Open this CSV file in Excel and compute the average length of flowlines.

The attribute table for Catchment has a field **AreaSqKM** from the original data. Use this field to similarly evaluate the average area of catchments.

Note that the fields Shape_Length and Shape_Area in these tables should not be used for length and area as they are in geographic coordinates so do not account for the curvature of the earth.

To be turned in: Make a map of the San Marcos basin with its labeled rivers. How many Catchments lie within this basin? What is their average area (Sq. Km)? How many Flowlines lie within this basin? What is their average length (Km)?

Creating a Point Feature Class of Stream Gages

Now you are going to build a new Feature Class yourself of stream gage locations in the San Marcos basin. I have extracted information from the USGS site information at http://waterdata.usgs.gov/tx/nwis/si

SiteID	SiteName	Latitude	Longitude	DASqMile	MAFlow

08171000	Blanco Rv at Wimberley, Tx	29º 59' 39"	98º 05' 19"	355	142
08171300	Blanco Rv nr Kyle, Tx	29º 58' 45"	97º 54' 35"	412	165
08172400	Plum Ck at Lockhart, Tx	29º 55' 22"	97º 40' 44"	112	49
08173000	Plum Ck nr Luling, Tx	29º 41' 58"	97º 36' 12"	309	114
08172000	San Marcos Rv at Luling, Tx	29º 39' 58"	97º 39' 02"	838	408
08170500	San Marcos Rv at San Marcos, Tx	29º 53' 20"	97º 56' 02"	48.9	176

(a) Define a table containing an ID and the long, lat coordinates of the gages

The coordinate data is in geographic degrees, minutes, & seconds. These values need to be converted to digital degrees, so go ahead and perform that computation for the 8 pairs of longitude and latitude values. This is something that has to be done carefully because any errors in conversions will result in the stations lying well away from the San Marcos basin. I suggest that you prepare an Excel table showing the gage longitude and latitude in degrees, minutes and seconds, convert it to long, lat in decimal degrees:

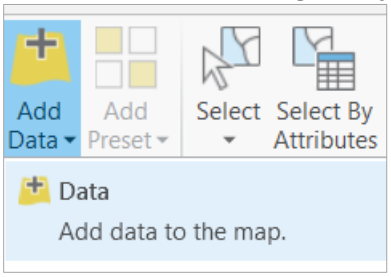
$$Decimal\ Degrees\ (DD)\ =\ Degrees\ +\ \frac{Min}{60}\ +\ \frac{Seconds}{3600}$$

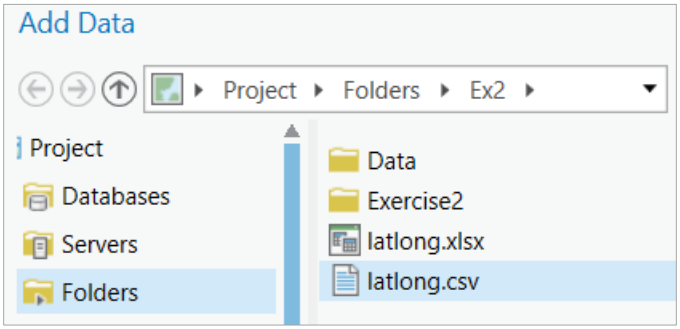
Remember that West Longitude is negative in decimal degrees. Shown below is a table that I created. **Be sure to format the columns containing the Longitude and Latitude data in decimal degrees (LongDD and LatDD) so that they explicitly have Number format with 4 decimal places using Excel format procedures. Format the column SITEID as Text or it will not retain the leading zero in the SiteID data**. Add the additional information about the USGS SiteID, SiteName, and Mean Annual Flow (MAF). Note the name of the worksheet that you have stored the data in. I have called mine **latlong.csv**. Note that this ArcGIS Pro does not support Excel tables, and therefore you *must* save your table as a .csv for this step to work. Close Excel before you proceed back to ArcGIS Pro.

SiteID	SiteName	Latitude	Longitude	LatDeg	LatMin	LatSec	LongDeg	LongMin	LongSec	LatDD	LongDD	DASqMile	MAFlow
08171000	Blanco Rv at Wimberley, Tx	29º 59' 39"	98º 05' 19"	29	59	39	98	5	19	29.9942	-98.0886	355	142
08171300	Blanco Rv nr Kyle, Tx	29º 58' 45"	97º 54' 35"	29	58	45	97	54	35	29.9792	-97.9097	412	165
08172400	Plum Ck at Lockhart, Tx	29º 55' 22"	97º 40' 44"	29	55	22	97	40	44	29.9228	-97.6789	112	49
08173000	Plum Ck nr Luling, Tx	29º 41' 58"	97º 36' 12"	29	41	58	97	36	12	29.6994	-97.6033	309	114
08172000	San Marcos Rv at Luling, Tx	29º 39' 58"	97º 39' 02"	29	39	58	97	39	2	29.6661	-97.6506	838	408
08170500	San Marcos Rv at San Marcos, Tx	29º 53' 20"	97º 56' 02"	29	53	20	97	56	2	29.8889	-97.9339	48.9	176

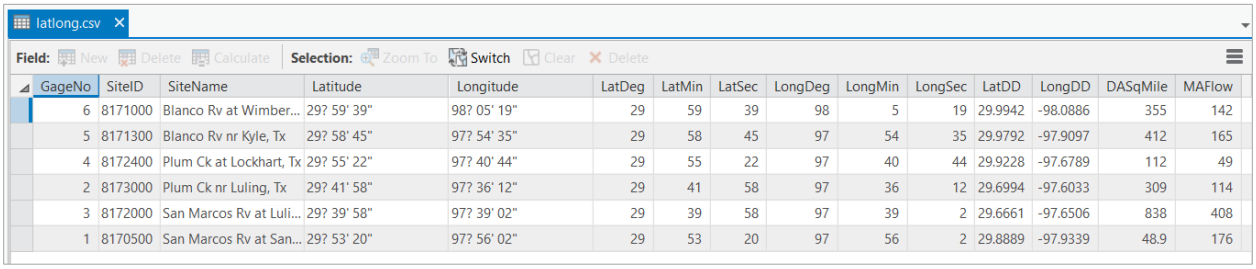
(b) Creating and Projecting a Feature Class of the Gages

(1) Open **ArcGIS Pro** and the **Exercise2.aprx** file you created earlier in this exercise. Select the **add data** button and navigate to your .csv file.





Hit **Select** and your table will be added to ArcGIS Pro. Pretty cool!! It has always been a struggle to add data from spreadsheets before, and it seems like with ArcGIS Pro they have gotten this right.

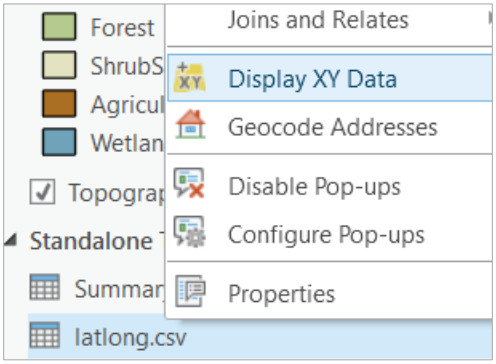

latlong.csv

Field: New Delete Calculate | Selection: Zoom To Switch Clear Delete

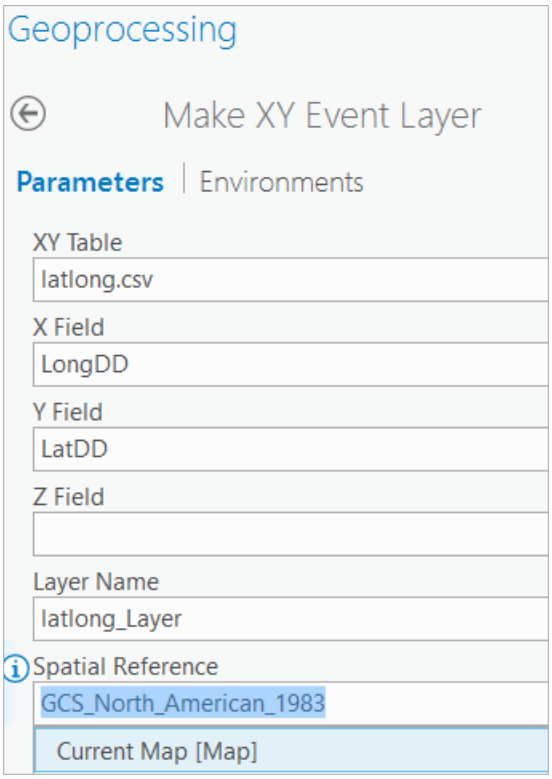
GageNo	SiteID	SiteName	Latitude	Longitude	LatDeg	LatMin	LatSec	LongDeg	LongMin	LongSec	LatDD	LongDD	DASqMile	MAFlow
6	8171000	Blanco Rv at Wimber...	29? 59' 39"	98? 05' 19"	29	59	39	98	5	19	29.9942	-98.0886	355	142
5	8171300	Blanco Rv nr Kyle, Tx	29? 58' 45"	97? 54' 35"	29	58	45	97	54	35	29.9792	-97.9097	412	165
4	8172400	Plum Ck at Lockhart, Tx	29? 55' 22"	97? 40' 44"	29	55	22	97	40	44	29.9228	-97.6789	112	49
2	8173000	Plum Ck nr Luling, Tx	29? 41' 58"	97? 36' 12"	29	41	58	97	36	12	29.6994	-97.6033	309	114
3	8172000	San Marcos Rv at Luli...	29? 39' 58"	97? 39' 02"	29	39	58	97	39	2	29.6661	-97.6506	838	408
1	8170500	San Marcos Rv at San...	29? 53' 20"	97? 56' 02"	29	53	20	97	56	2	29.8889	-97.9339	48.9	176

Now we are going to convert the tabular data in the spreadsheet to points in the ArcGIS Pro display.

(2) **Right click** on the new table, **latlong.csv**, and select **Display XY Data**

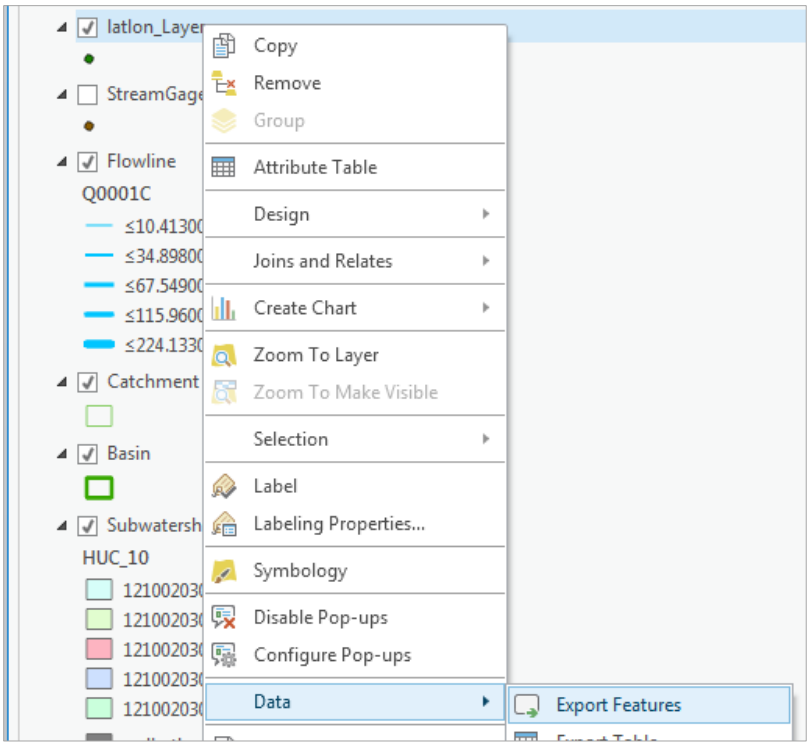


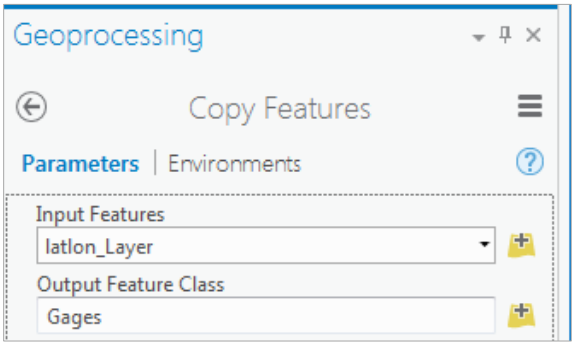
(3) Set the X Field to **LongDD**, the Y Field to **LatDD**. Note that by default the **GCS_WGS_1984** coordinate system is chosen. This is incorrect for this dataset and must be changed to **GCS_North_American_1983**.



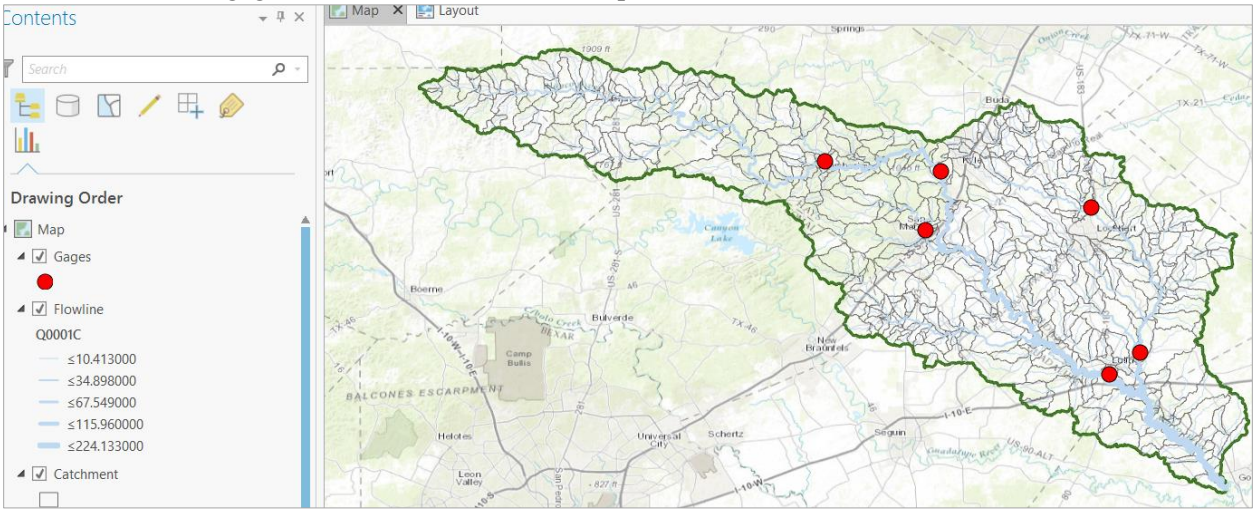
Hit **Run** to create the and voila! Your gage points show up on the map right along the San Marcos River just like they should. Magic! I remember the first time I did this I was really thrilled. This stuff really works. I can create data points myself! If you don't see any points, don't be dismayed. Check back at your spreadsheet to make sure that the correct X field and Y field have been selected as the ones that have your data in decimal degrees.

Now let's store these points in our geodatabase as a real feature class called **Gages**. Right click on **latlon_Layers** (or possibly something else, depending on what your Layer Name was) and **Export Features** to convert the points into a **Gages** feature class in the **SanMarcos** feature dataset as you did earlier with Basin and Watershed.

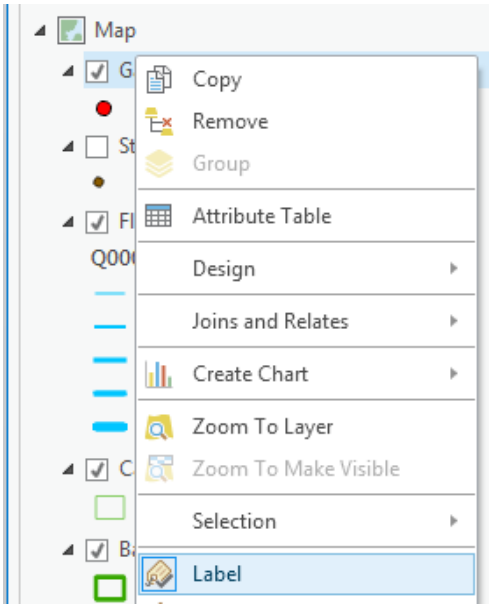




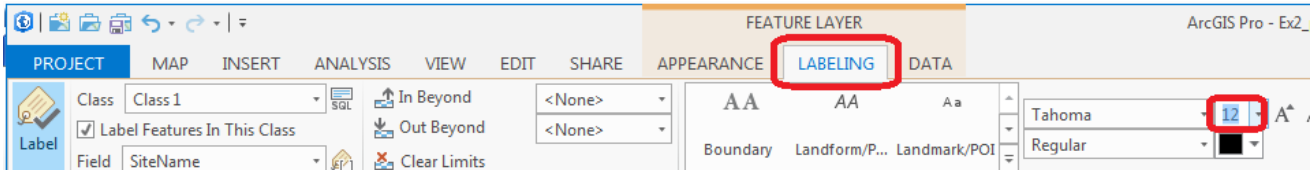
Let's recolor these gages to be nice red dots with 10 point size.



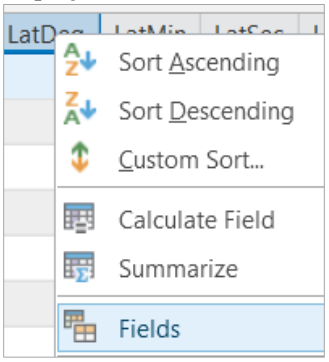
Now let's label the Gages with their Names. Right click on the **Gage** feature class and click on **Label Features**. You'll see some labels show up in small lettering. Check your previous layout to make sure that all labels and text boxes show up correctly. If a text box is blocking a gage label, drag the textbox somewhere else.

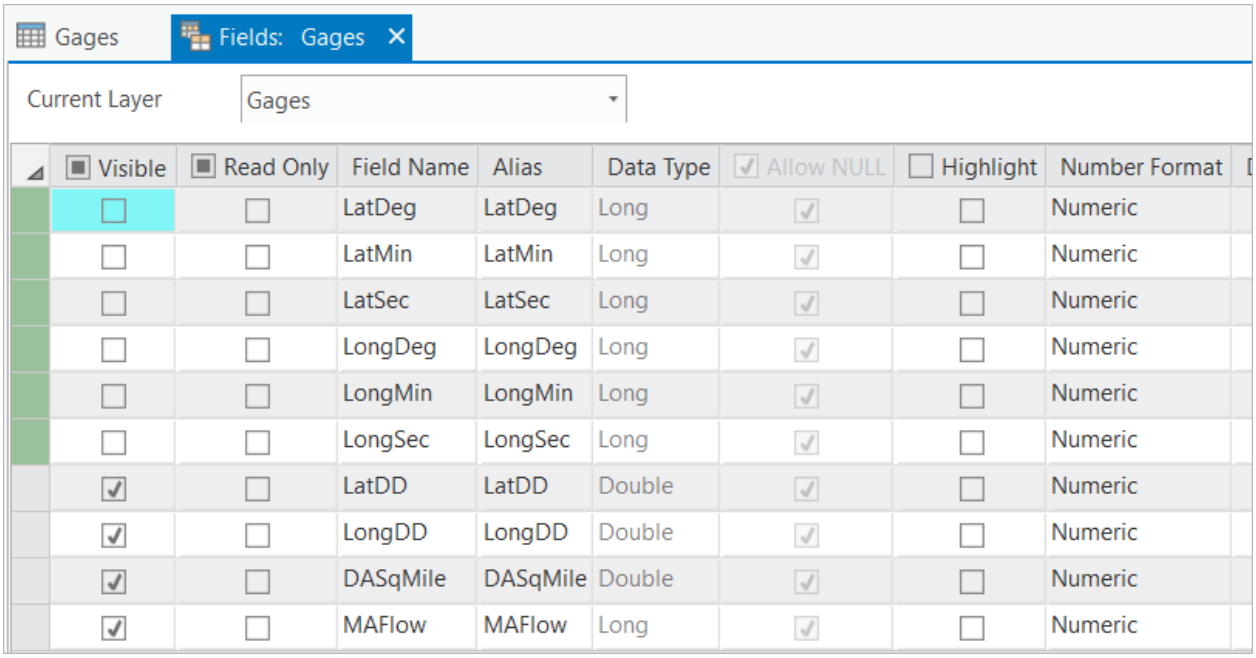


To resize the labels, go to the *Labeling* tab and select 12 point font.



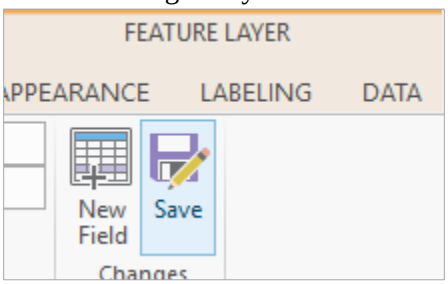
Open the **Attribute Table** of the **Gages,** and use the **Fields** view to turn off the fields that you don't want displayed



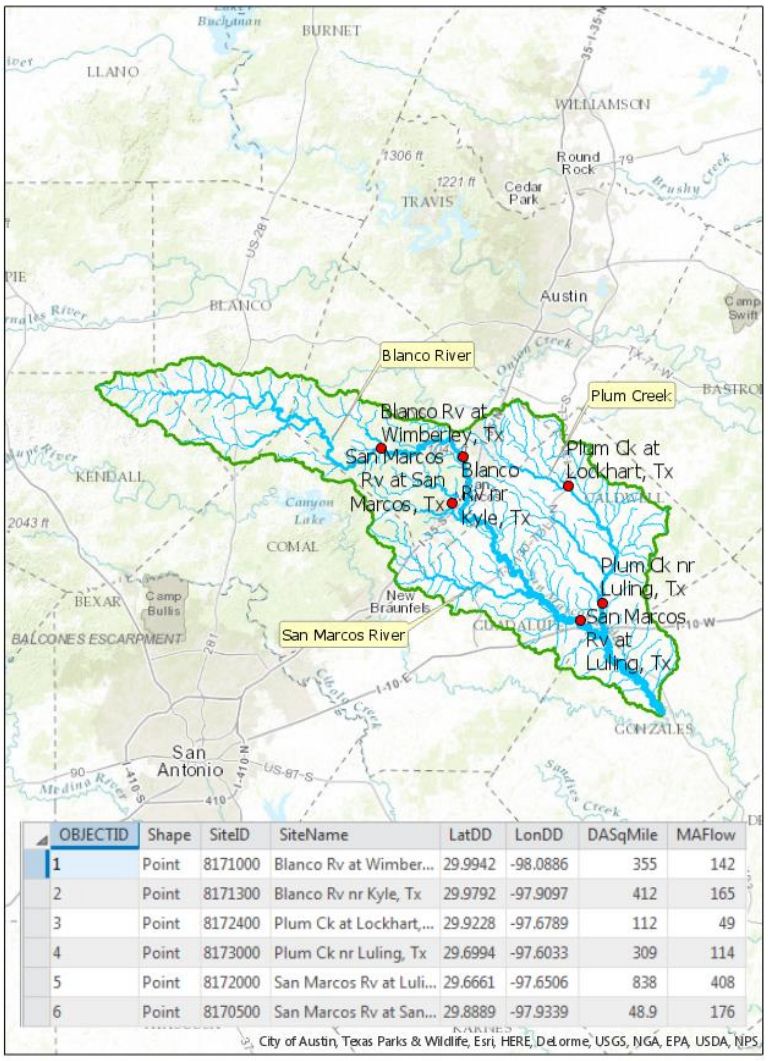


Visible	Read Only	Field Name	Alias	Data Type	Allow NULL	Highlight	Number Format
☐	☐	LatDeg	LatDeg	Long	☑	☐	Numeric
☐	☐	LatMin	LatMin	Long	☑	☐	Numeric
☐	☐	LatSec	LatSec	Long	☑	☐	Numeric
☐	☐	LongDeg	LongDeg	Long	☑	☐	Numeric
☐	☐	LongMin	LongMin	Long	☑	☐	Numeric
☐	☐	LongSec	LongSec	Long	☑	☐	Numeric
☑	☐	LatDD	LatDD	Double	☑	☐	Numeric
☑	☐	LongDD	LongDD	Double	☑	☐	Numeric
☑	☐	DASqMile	DASqMile	Double	☑	☐	Numeric
☑	☐	MAFlow	MAFlow	Long	☑	☐	Numeric

Save the changes to your table view:



Make a **Layout** like that shown below and save your project as **Ex2_projects_gages.aprx**.



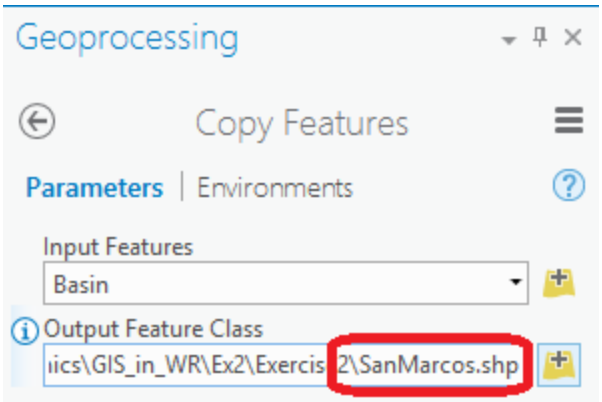
OBJECTID	Shape	SiteID	SiteName	LatDD	LonDD	DASqMile	MAFlow
1	Point	8171000	Blanco Rv at Wimber...	29.9942	-98.0886	355	142
2	Point	8171300	Blanco Rv nr Kyle, Tx	29.9792	-97.9097	412	165
3	Point	8172400	Plum Ck at Lockhart,...	29.9228	-97.6789	112	49
4	Point	8173000	Plum Ck nr Luling, Tx	29.6994	-97.6033	309	114
5	Point	8172000	San Marcos Rv at Luli...	29.6661	-97.6506	838	408
6	Point	8170500	San Marcos Rv at San...	29.8889	-97.9339	48.9	176

To be turned in: A layout showing a map and table describing the flow gages in the San Marcos Basin

Flow Data for the Blanco River

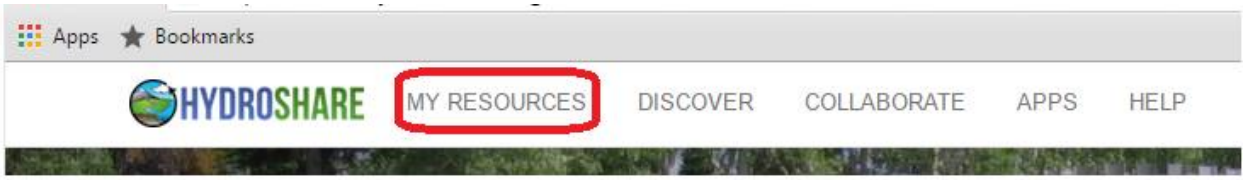
In this section we will use the HydroShare National Water Model Forecast Viewer to obtain streamflow forecast data for the San Marcos River. Export the San Marcos Basin feature class as a shapefile to import into HydroShare to assist with identifying reaches where there are National Water Model forecasts.

Right click on the Basin feature class and Export Features. For Output Feature Class set the output as SanMarcos.shp in your Exercise2 folder.

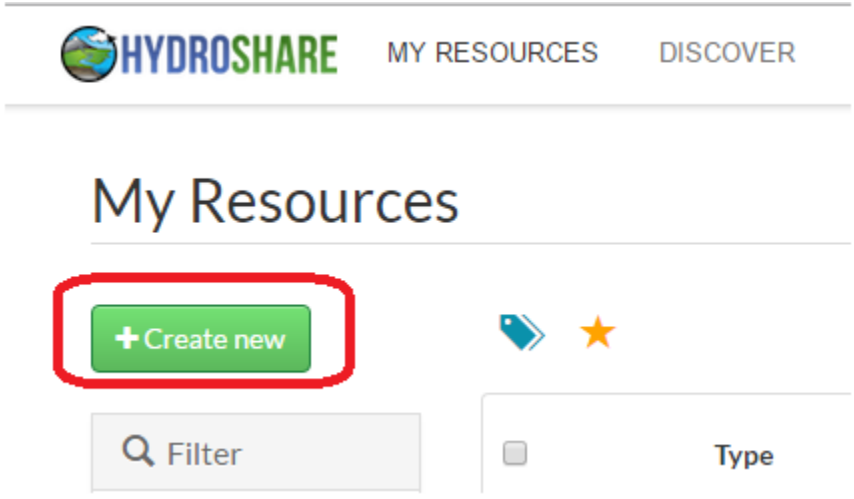


Click **Run**.

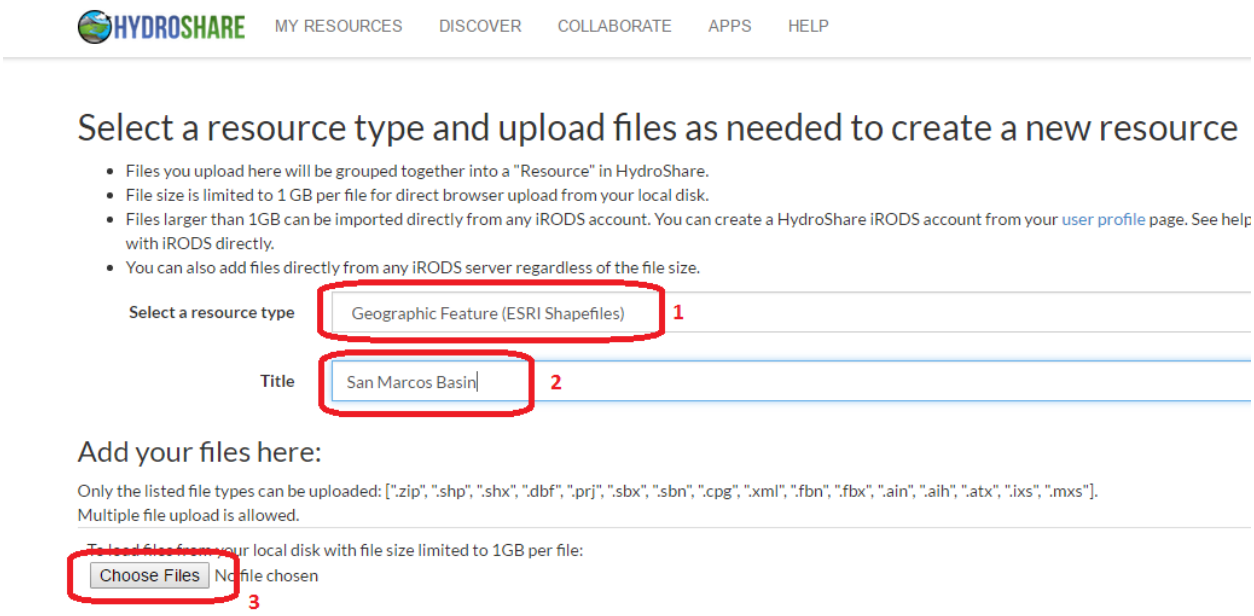
Use the **Chrome** web viewer for the rest of this task. Open HydroShare at http://www.hydroshare.org. If this is the first time you have been there click Sign up now to create an account. Otherwise click sign in. Once you have an account and are signed in click on My Resources



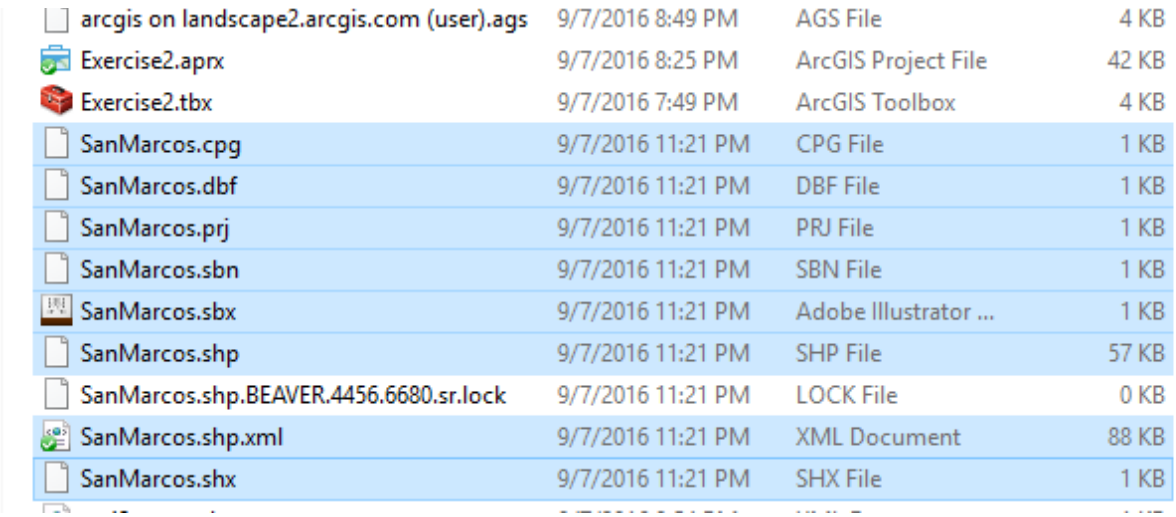
Click on Create New



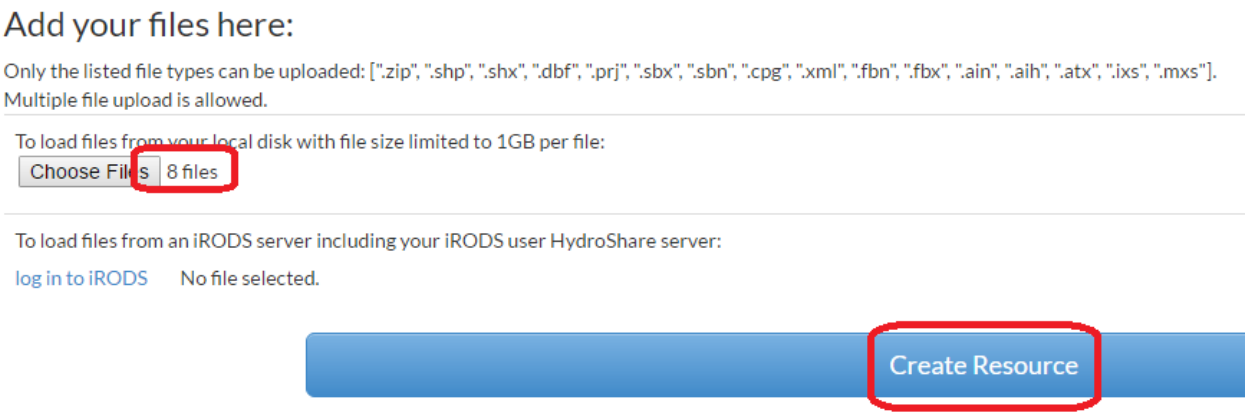
Then select resource type "Geographic Feature (ESRI Shapefiles)". For title enter "San Marcos Basin"



Click on Choose Files and browse to select the 8 shapefiles that comprise the San Marcos Basin shapefile that you just exported from ArcGIS Pro

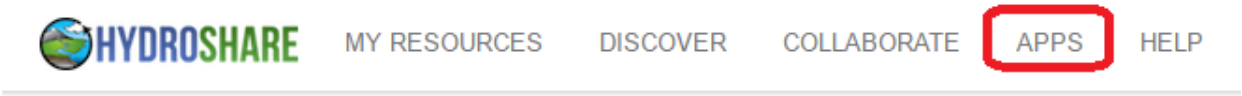


Click Open. Then click Create Resource.

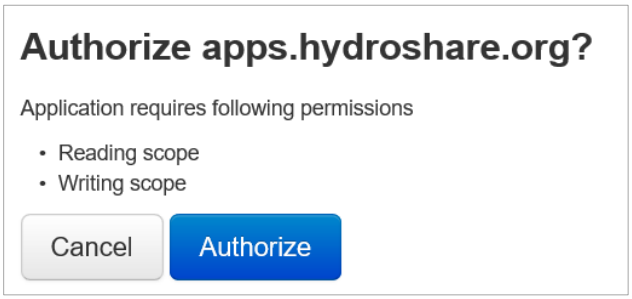


After a short while your San Marcos Basin HydroShare resource will be created.

Click on Apps and,

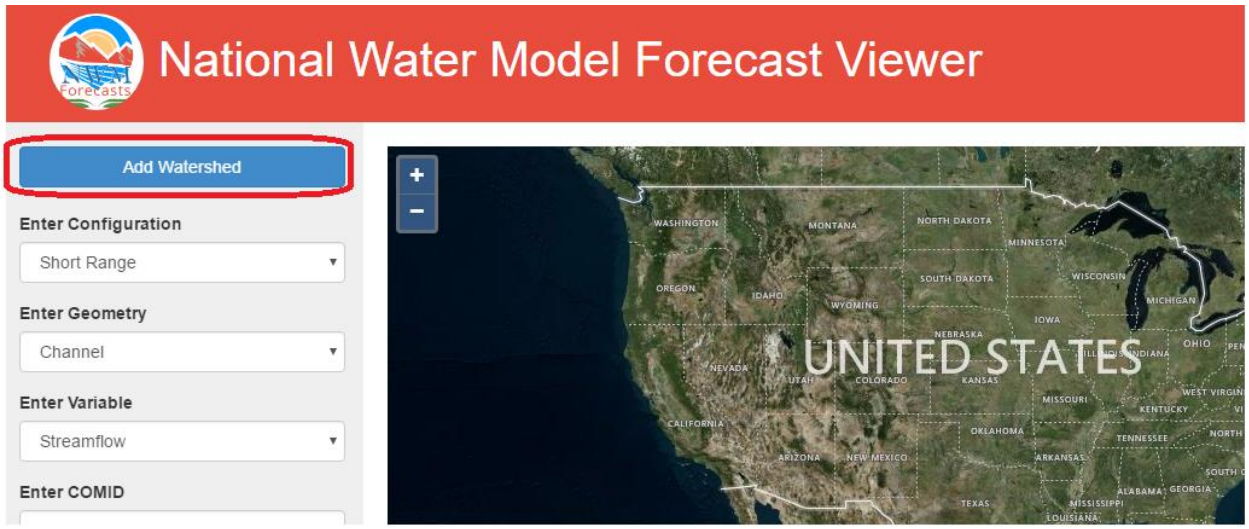


Authorize apps.hydroshare.org. Note that you are authorizing the app to access data that you have in HydroShare. This authorization will be used to access the San Marcos Basin resource you just created.

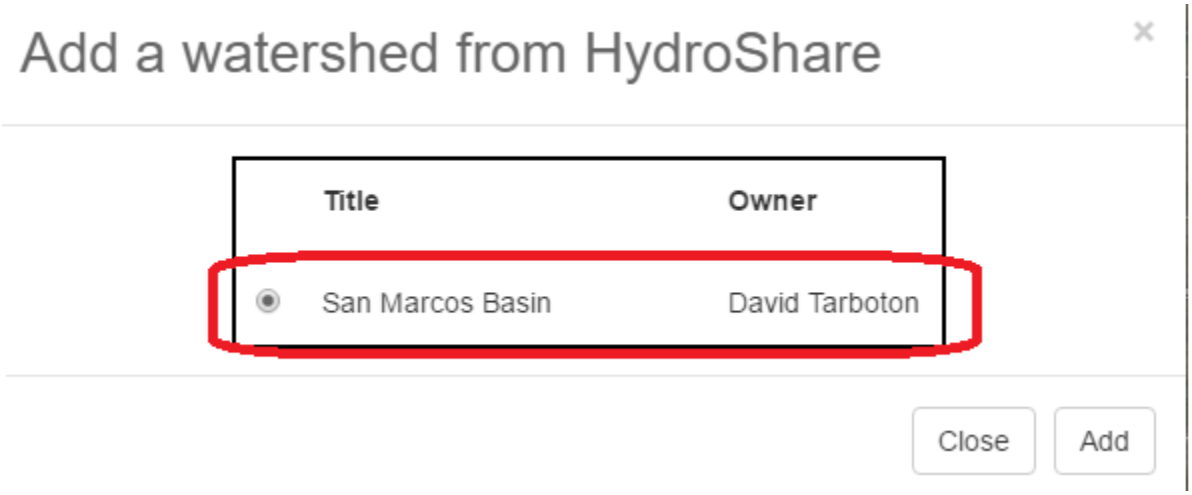


Select the National Water Model Forecast Viewer.

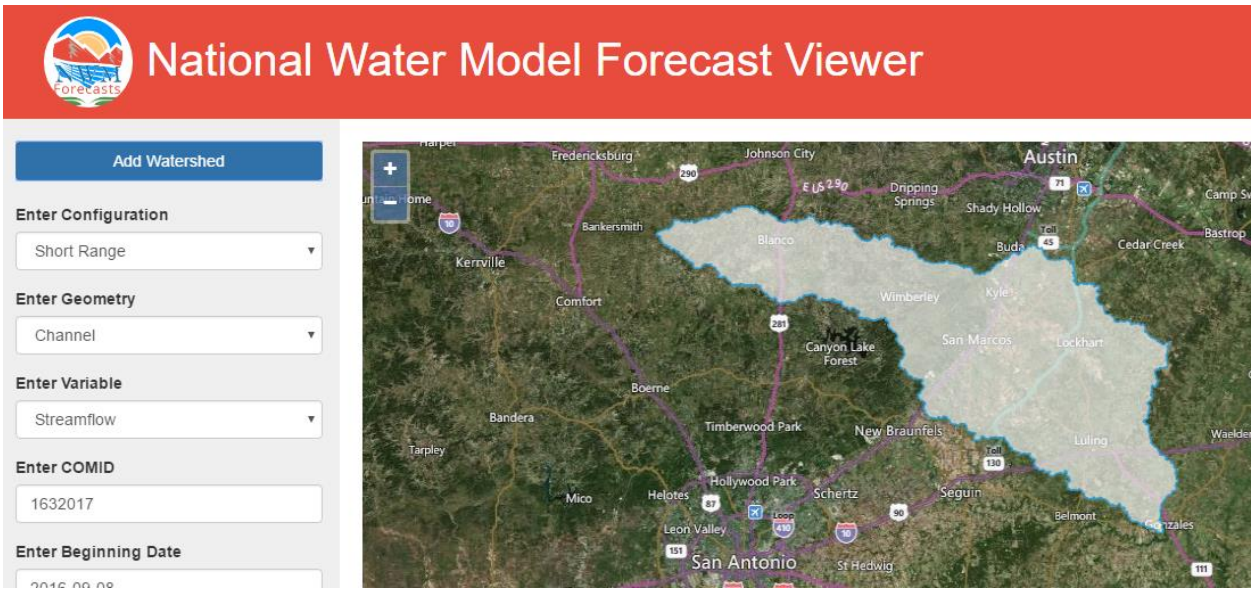
Click on Add Watershed



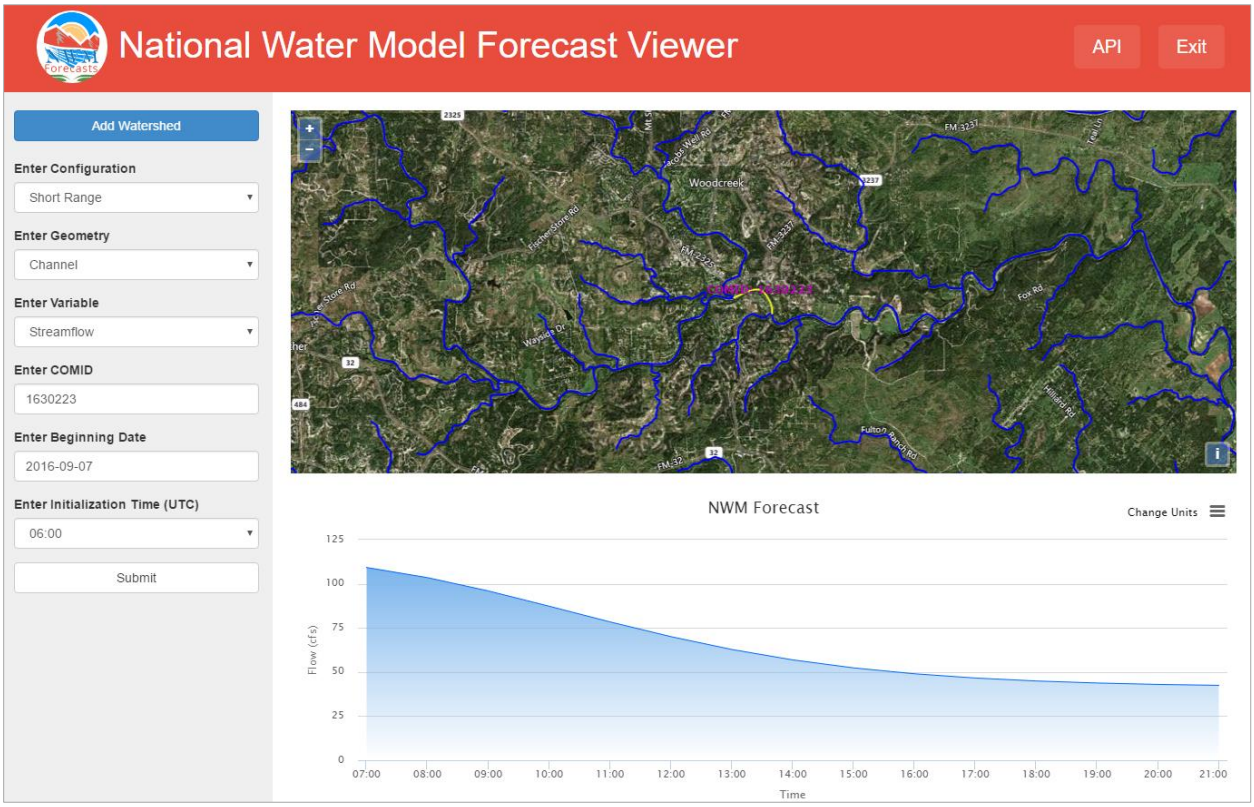
Click on San Marcos Basin and Add



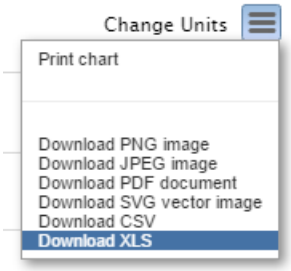
The display should zoom in to the San Marcos Basin in the Map Viewer.



Zoom in further until you can see the town of Wimberley on your map and are close enough to see a stream map appear. If you click on the stream segment you identified earlier in the exercise, you'll see it is yellow and labelled 1630223. Make the following selections in the left panel for Blanco River at Wimberley, with COMID **1630223**. Hit **Submit**. After a while you'll see a forecast appear in the lower pane.



Right click on the upper right corner of the chart panel, and you can download the forecast data as an Excel file

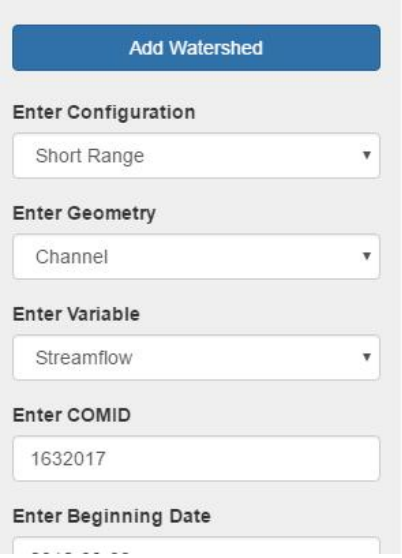


This resultant excel file will look something like this:

	A	B
1	**DateTime**	**Flow (cfs)**
2	9/7/2016 7:00	109.24
3	9/7/2016 8:00	103.50
4	9/7/2016 9:00	95.96
5	9/7/2016 10:00	87.30
6	9/7/2016 11:00	78.40
7	9/7/2016 12:00	70.05
8	9/7/2016 13:00	62.78
9	9/7/2016 14:00	56.88
0	9/7/2016 15:00	52.34
1	9/7/2016 16:00	48.99
2	9/7/2016 17:00	46.59
3	9/7/2016 18:00	44.92
4	9/7/2016 19:00	43.77
5	9/7/2016 20:00	42.98
6	9/7/2016 21:00	42.45

Pretty cool! You now have a forecast from the National Water Model for the Blanco River!

Pan the map to the south east (bottom right) and click on the most downstream stream segment in the San Marcos Basin (COMID 1632017)



Obtain a streamflow forecast for this location too.

To be turned in: Screen captures of your National Water Model forecasts. Prepare an Excel chart that shows the two forecasts. Compare the Blanco forecast flows with those measured at the Blanco River at Wimberley (USGS gage 08171000). Calculate the fraction of flow at the most downstream end that is from the Blanco river at Wimberley.

Ok, you're done!

Summary of Items to be Turned in:

1. *Make a map of the San Marcos basin with its HUC10 and HUC12 watersheds and subwatersheds. How many HUC10 and HUC12 units exist in the San Marcos Basin? Note that maps that you turn in should be clearly labeled so that they may be unambiguously interpreted with a title, scale, north arrow and appropriate legend information.*
2. *Make a map of the land cover variation over the San Marcos Basin. Prepare a table that shows the area (km^2) of each of the seven main land cover classes and the % of the total basin area that each represents.*
3. *Make a map of the San Marcos basin with its labeled rivers. How many Catchments lie within this basin? What is their average area (Sq. Km)? How many Flowlines lie within this basin? What is their average length (Km)*
4. *A layout showing a map and table describing the flow gages in the San Marcos Basin*
5. *Screen captures of your National Water Model forecasts. Prepare an Excel chart that shows the two forecasts. Compare the Blanco forecast flows with those measured at the Blanco River at Wimberley (USGS gage 08171000. Calculate the fraction of flow at the most downstream end that is from the Blanco river at Wimberley.*