Exercise 2

Prepared by Ayman Alafifi, Irene Garousi-Nejad and David G. Tarboton
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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 ArcGIS Online. You will locate, extract and summarize land cover data for this watershed.

Overview and Computer and Data Requirements

To carry out this exercise, you need to have a computer which runs ArcGIS Pro version 2.0. You will also need an ArcGIS Organizational Account to enable you to login to ArcGIS Online.

In the first part of this exercise basemap data for the San Marcos Basin is developed using the mapping and analysis capability of ArcGIS Online. Then, to ingest Raster landcover data the online map is opened using ArcGIS Pro and landcover data analyzed using ArcGIS Pro on the Desktop. Data required is accessed from either the ESRI Living Atlas, or the National Map.

Getting Started

Sign in to ArcGIS Online

Begin by going to ArcGIS webpage at https://www.arcgis.com/home/index.html and sign in using your ESRI username and password.
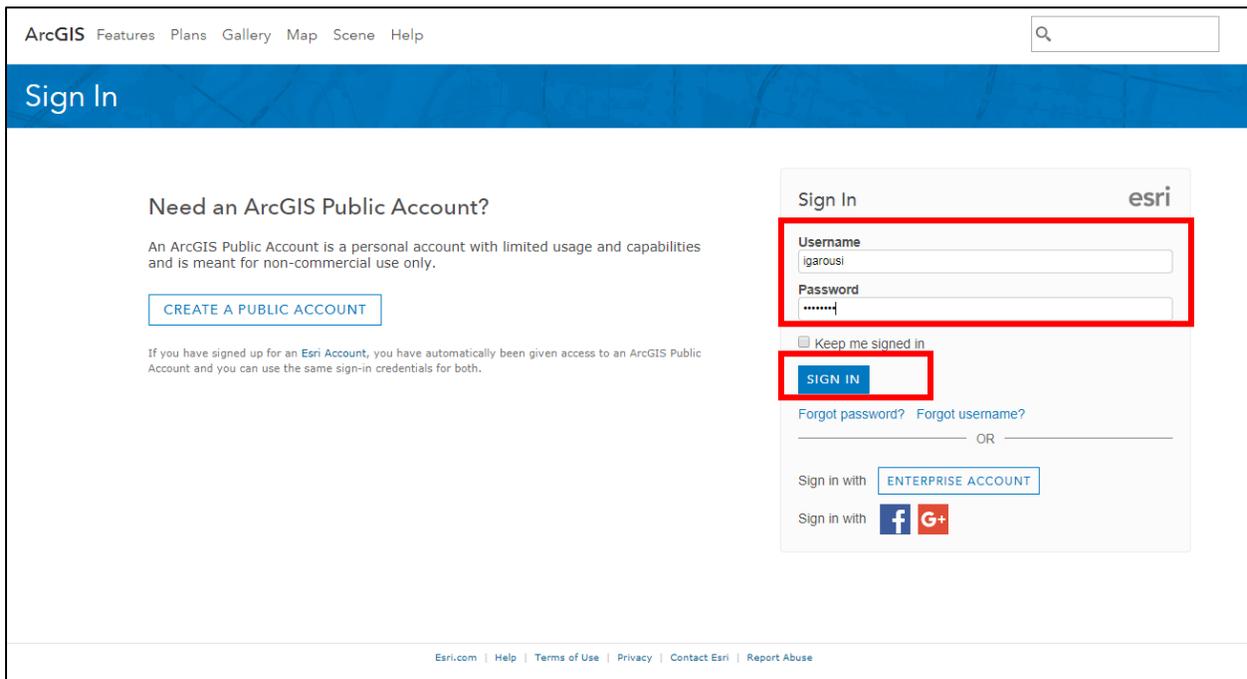
After signing in, you should be able to see your home page, which shows you the institution through which you get connected to ESRI. Now, click on **Content** at the top menu bar.

You should see a listing of content you have developed, including (and perhaps only) the evaporation map developed for exercise 1. In this exercise we are going to use ArcGIS online web mapping functionality to create a basemap for a study area. The online web mapping environment provides considerable GIS functionality, and is part of a general trend towards cloud based software (like Google Docs). It is conceivable in the future that a Desktop GIS may not be needed and you do everything in the Browser. At the current stage of development ArcGIS Pro and ArcGIS Online are closely aligned and interoperable and this exercise will expose you to online GIS tools for the development of some basemap content using data from the ESRI Living Atlas of the World catalogue. Then it will transition back to ArcGIS Pro on your desktop for basemap information extracted from the National Map, where the online data is not published in a way that it can be manipulated online.

Create a Map

Click on **Create** and click on **Map**.
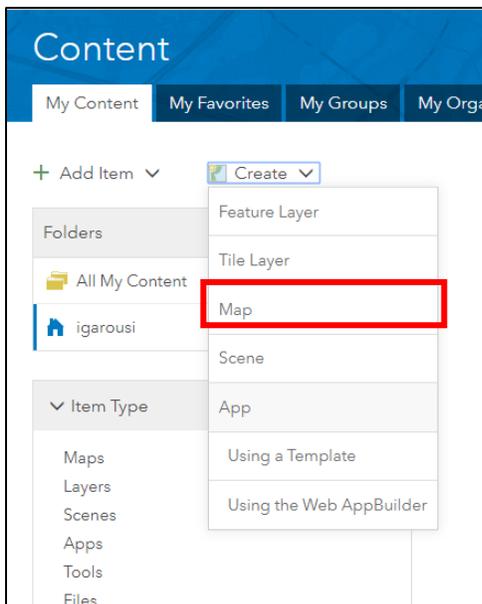
Now you need to enter a **title** and some **tags** for your project. In this exercise, let us name the project Exercise 2 and use GISWR2017 as a tag. Note that after entering the text for the tag, you need to use the **tab** button so that the tag could be accepted. Then, if you want you can write a summary of this map or leave it blank. You can also organize your online content into folders. In the below, I have used a folder GISWR2017. Click **OK** to create your map.

The new map should appear as follows:
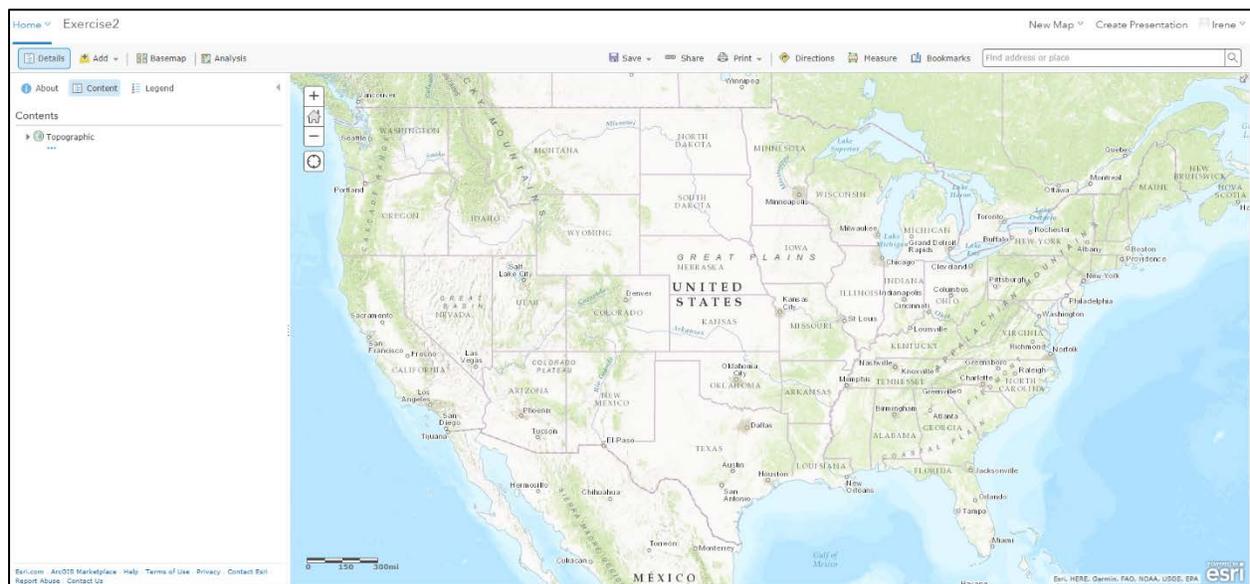
Obtain National Hydrography Data from Living Atlas

Click on **Add** and choose **Browse Living Atlas Layers**.
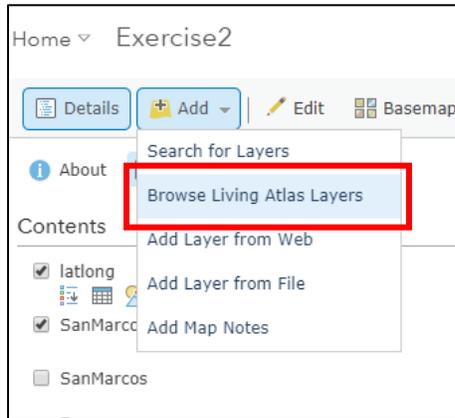
From **Browse Living Atlas Layer** select the category Water and search on NHDPlus.
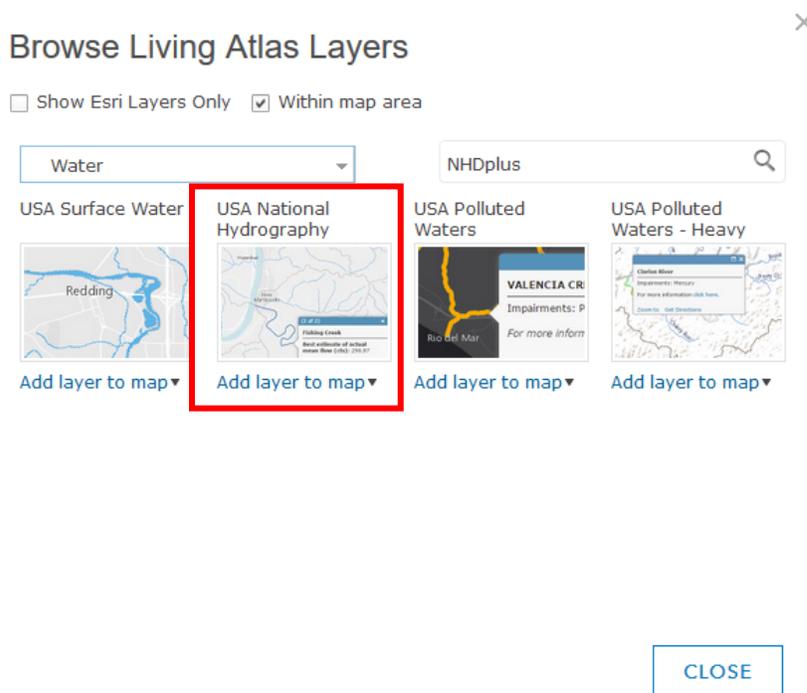
Click Close. After adding this layer, your map show the USA National Hydrography Dataset Plus Version 2.1 – Seamless layer.
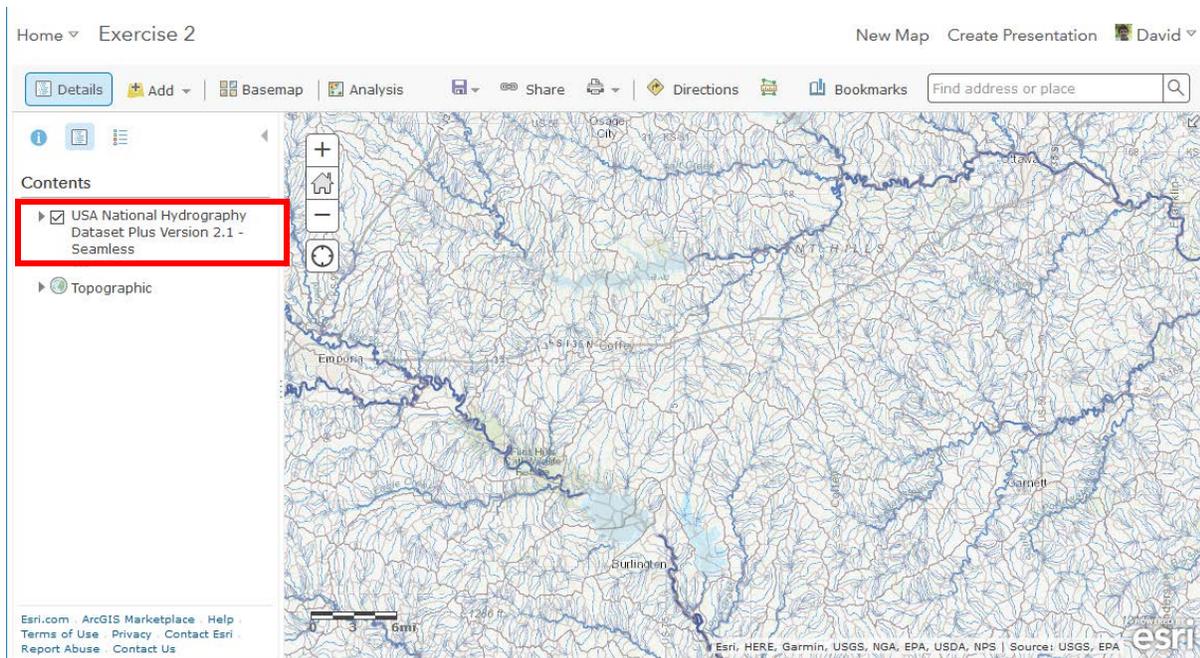
Note that the map automatically zooms in to a resolution where you can see the detail of this dataset. The NHDPlus layer is configured so that it limits the levels at which sublayers are displayed at different scales. If you zoomed out, you will see that most sublayers within NHDPlus dataset will no longer be visible.

Click on the … beneath the layer entry in the table of contents and show item details.
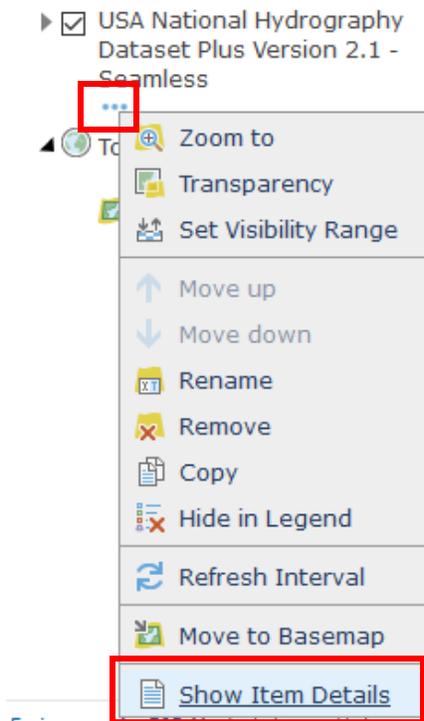
This opens a new browser tab that gives metadata on this layer. You should note that this layer holds many key features of the National Hydrography Dataset Plus Version 2.1 including rivers and streams (flowlines) and lakes, bays, and other water bodies (areas and waterbodies) as well as sinks, catchments and watershed boundaries. It is published by ESRI using source data from the USGS and EPA. After learning a bit about this data, go back to your Exercise 2 map tab.

Type **San Marcos** in the top right search box where it says Find address or place and select **San Marcos, TX, USA** from among the choices. This should zoom your map to San Marcos.
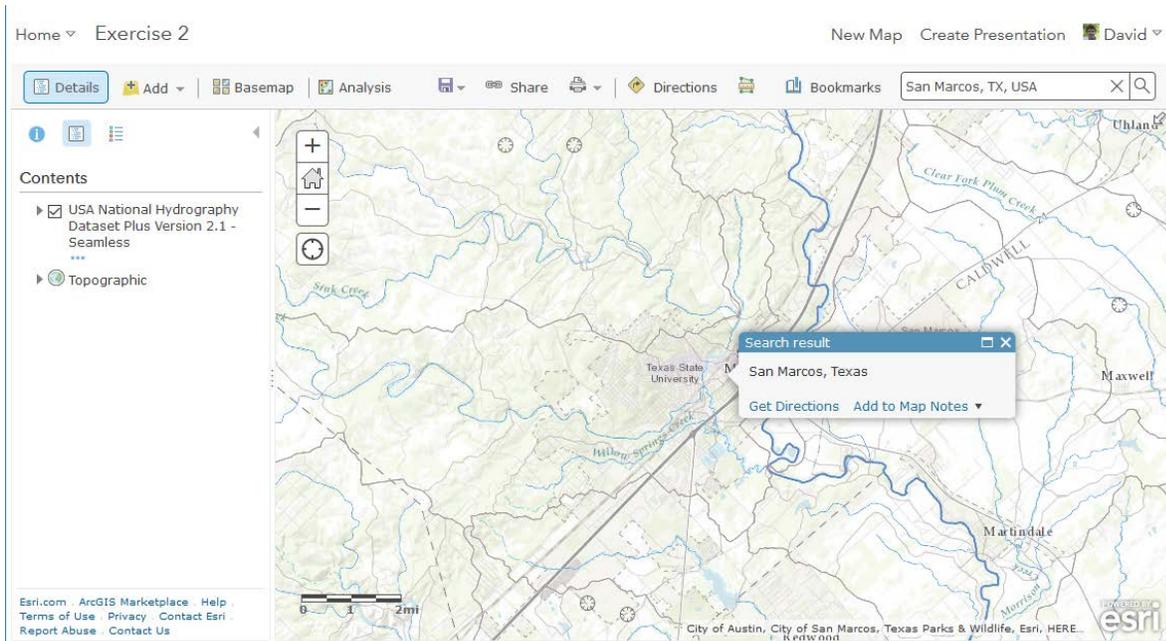
Click on the map and you will see that the selection identifies HUC12 subwatersheds in this area.
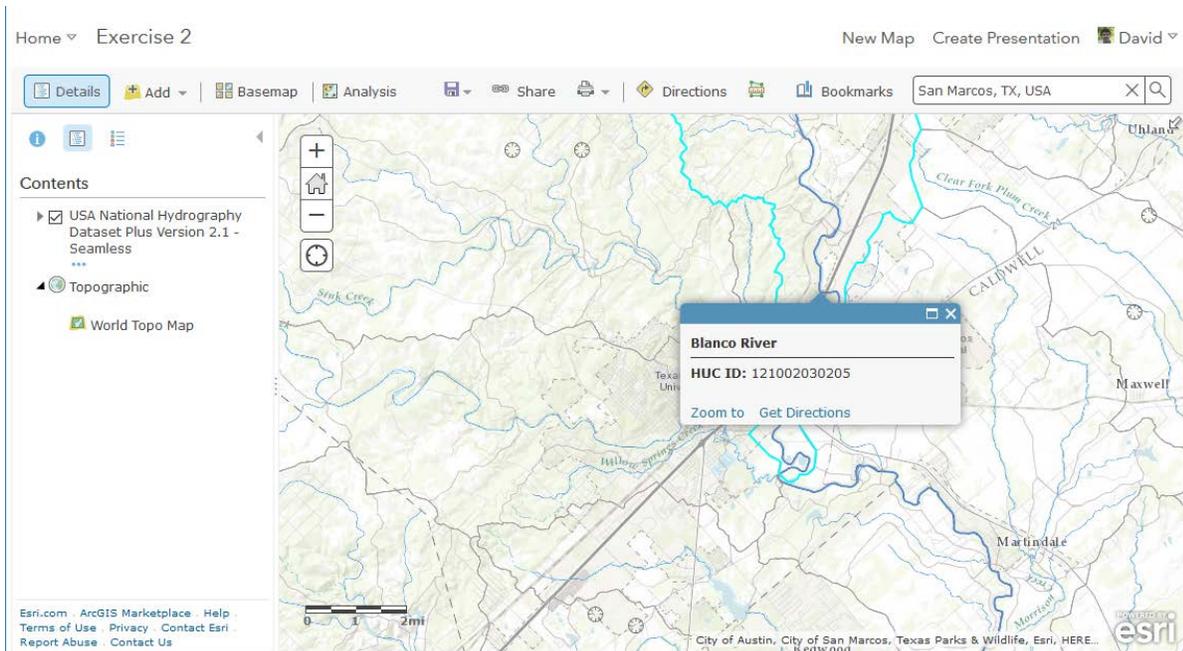
Expand the table of contents for USA National Hydrography Dataset Plus Version 2.1 – Seamless and click on the layer name Watershed Boundary Hydrologic Unit 12 to expand tools below it. Click on the table icon (show table) below the name of the layer.
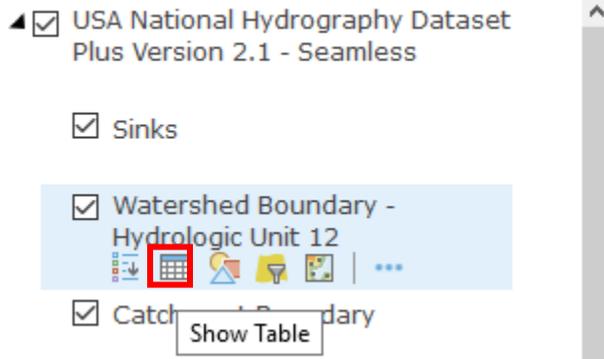
You should see a table at the bottom of the screen.

USA National Hydrography Dataset Plus Version 2.1 - Seamless - Watershed Boundary - Hydrologic Unit 12 (Features: 87685, Selected: 0)							
HUC 8 ID	HUC 10 ID	HUC 12 ID	Area (Acres)	HUC 10 GNIS ID	HUC 12 GNIS ID	HUC 10 Name	HUC 12 Name
14020002	1402000207	140200020702	9,094.00			Soap Creek-Blue Mesa Reservoir	Red Creek
14020002	1402000207	140200020703	19,606.00			Soap Creek-Blue Mesa Reservoir	West Elk Creek
14020002	1402000207	140200020704	28,360.00			Soap Creek-Blue Mesa Reservoir	West Soap Creek-Soap Creek

Note how the layout and behavior of this web map is similar to the layout and behavior of the ArcGIS Pro interface. Many of the concepts and skills you learn working with ArcGIS apply both to web mapping and desktop tools.

You can use the table options button to filter and select features and to center the map on a selected feature or set of features.
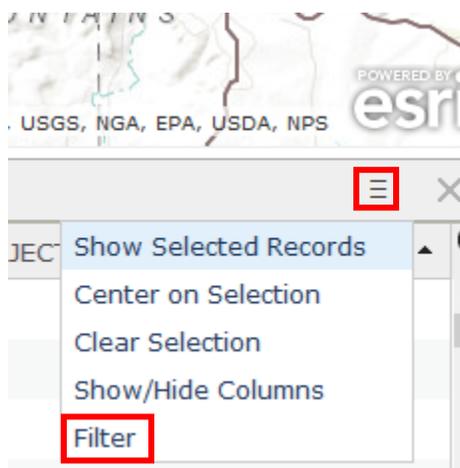
Click on Filter, then in the Create Filter window select HUC 8 ID is **12100203**. This is the HUC ID for the San Marcos Subbasin. Click Apply Filter.

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Filter: USA National Hydrography Dataset Plus Version 2.1 - Seamless - Watershed Boundary - Hydrologic Unit 12

Note that the table now only shows 32 Features. Previously it showed thousands.

HUC 8 ID	HUC 10 ID	HUC 12 ID	Area (Acres)	HUC 10 GNIS ID	HUC 12 GNIS ID	HUC 10 Name
12100203	1210020304	121002030406	31,225.00		1334034	Plum Creek
12100203	1210020305	121002030504	36,726.00		1347268	Lower San Marcos River

You can **click on feature records in the table, using shift to select multiple, to select all** the subwatersheds in the table, and **Center on Selection** to see outlines of the HUC 12 watersheds that comprise the San Marcos Subbasin.

Note that you have to be zoomed in close enough (or have a big screen) for these to be visible.

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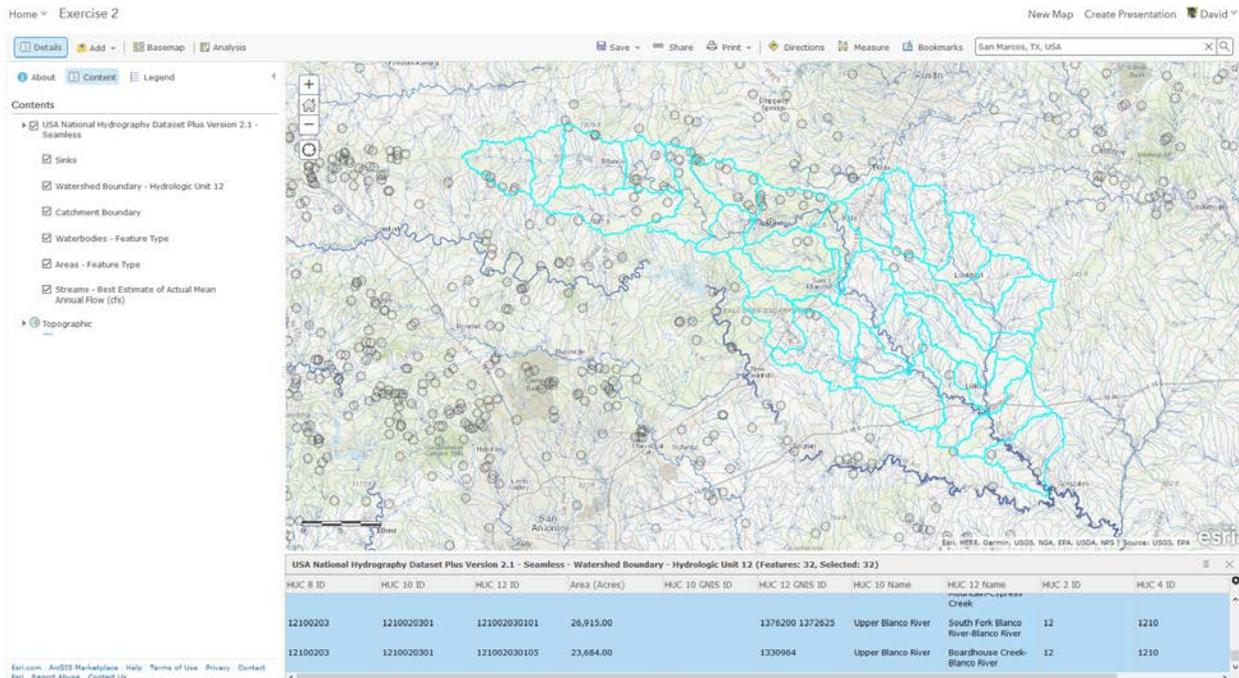
Query to select San Marcos HUC8 out of HUC12

As you work through the next few sections be on the lookout for the following quantities. When you come across them, record them, because they will be needed for items you should turn in.

- Area of San Marcos Subbasin in mi^2
- Number of HUC 12 subwatersheds in San Marcos Subbasin
- Average area of HUC 12 subwatersheds in San Marcos Subbasin in mi^2
- Number of NHDPlus Catchments in San Marcos Subbasin
- Average area of NHDPlus Catchments in San Marcos Subbasin in mi^2
- Number of NHDPlus stream reaches in San Marcos Subbasin
- Average length of NHDPlus stream reaches in San Marcos Subbasin in mi
- Total length of streams in San Marcos Subbasin in mi
- Mean annual flow at the outlet of the San Marcos Subbasin and at other locations within the San Marcos subbasin in cfs

You may need to do unit conversions, e.g. from Acres to mi^2 in these calculation. 1 mi^2 = 640 Acres

We want all the HUC12 subwatersheds that lie within the San Marcos Subbasin, which has a HUC8 value of 12100203.

Click on perform analysis below the table of contents entry for Watershed Boundary – Hydrologic Unit 12 in the Contents pane.
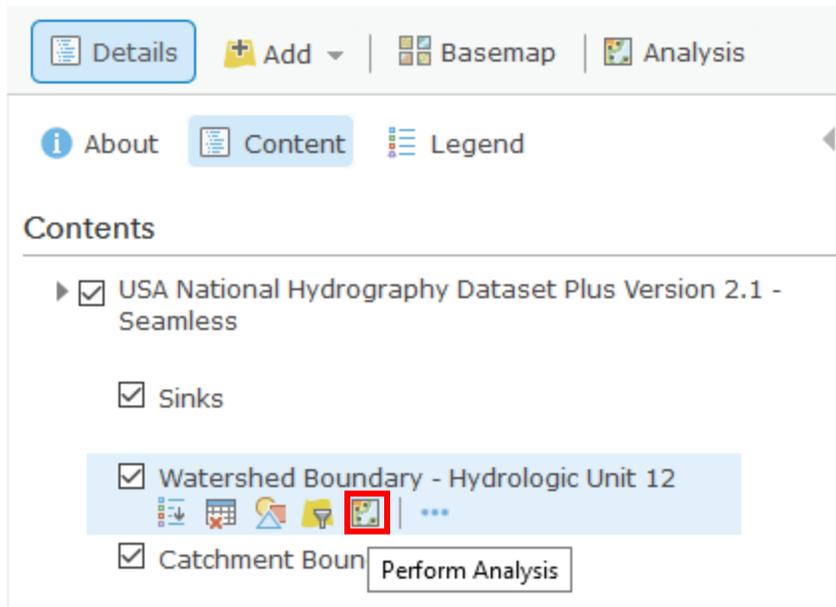
This leads you to where you can perform various analyses on the GIS layers. Note that for many online datasets in the Living Atlas and elsewhere the perform analysis button is not enabled. We selected this version of the NHD Plus dataset published by Esri because it does have analysis enabled.
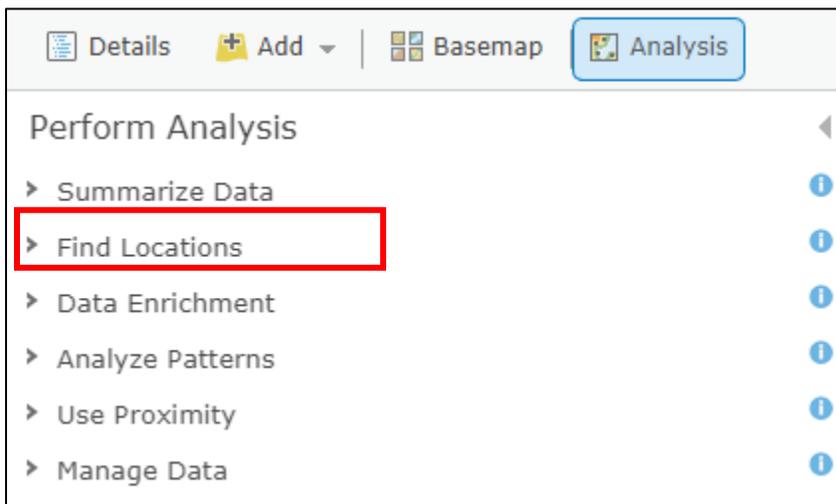
Here, we want to find all the HUC 12 subwatersheds which have a specific HUC 8 ID. To do so, we will implement **Find Existing Locations** from the **Find Location** option in the figure above. This selects existing features in our study are that meet a series of criteria we specify.
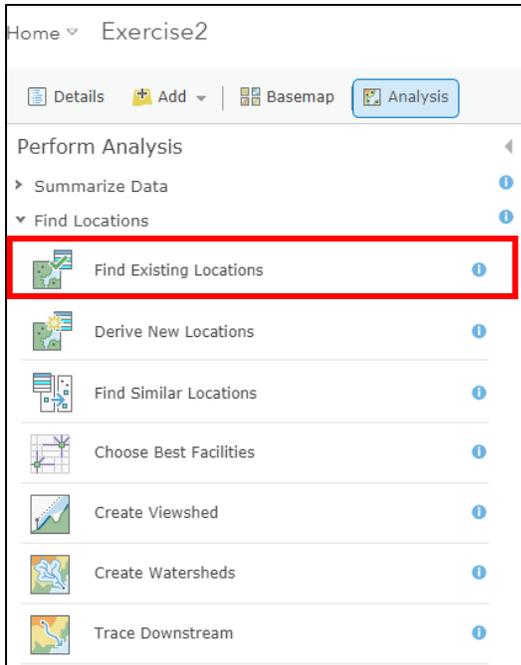
The criteria is HUC 8 ID is 12100203 and is implemented as follows:
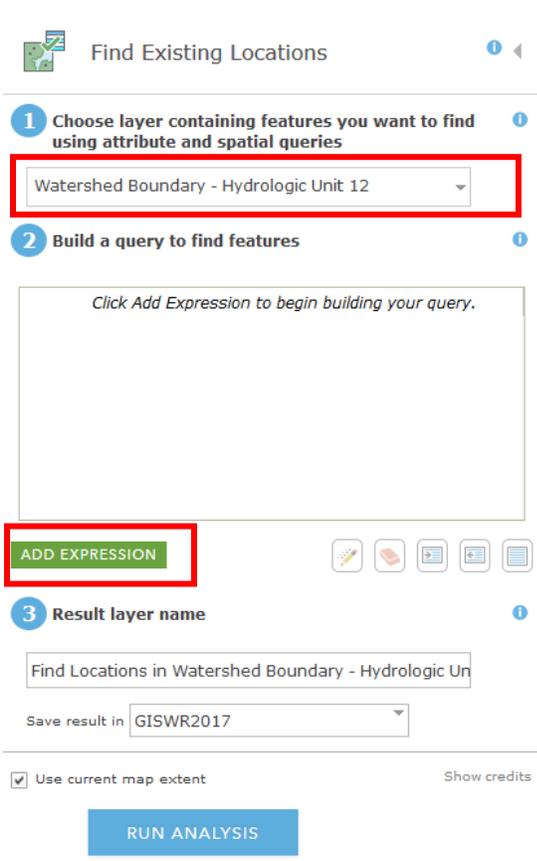
Add Expression

Watershed Boundary - Hydrologic Unit 12 ▾   where (attribute query) ▾

HUC 8 ID ▾   is ▾   12100203

◉ Value ○ Field ○ Unique

ADD   CLOSE

Find Existing Locations ❶ ◀

❶ **Choose layer containing features you want to find using attribute and spatial queries** ❶

Watershed Boundary - Hydrologic Unit 12 ▾

❷ **Build a query to find features** ❶

Watershed Boundary - Hydrologic Unit 12 *where HUC 8 ID is* '12100203'

ADD EXPRESSION

❸ **Result layer name** ❶

San Marcos DGT

Save result in   GISWR2017 ▾

☐ Use current map extent   Show credits

RUN ANALYSIS

Uncheck the Use current map extent because you may not be zoomed to an area including the subwatersheds you want to locate. It may take several minutes.

For result layer name you need to use a unique name within your organization (The whole of USU or UT Austin). We already used "San Marcos" in testing, so I suggest you each use San Marcos *** where *** is your initials. If you do not do this you may get the error

The result should be as follows:
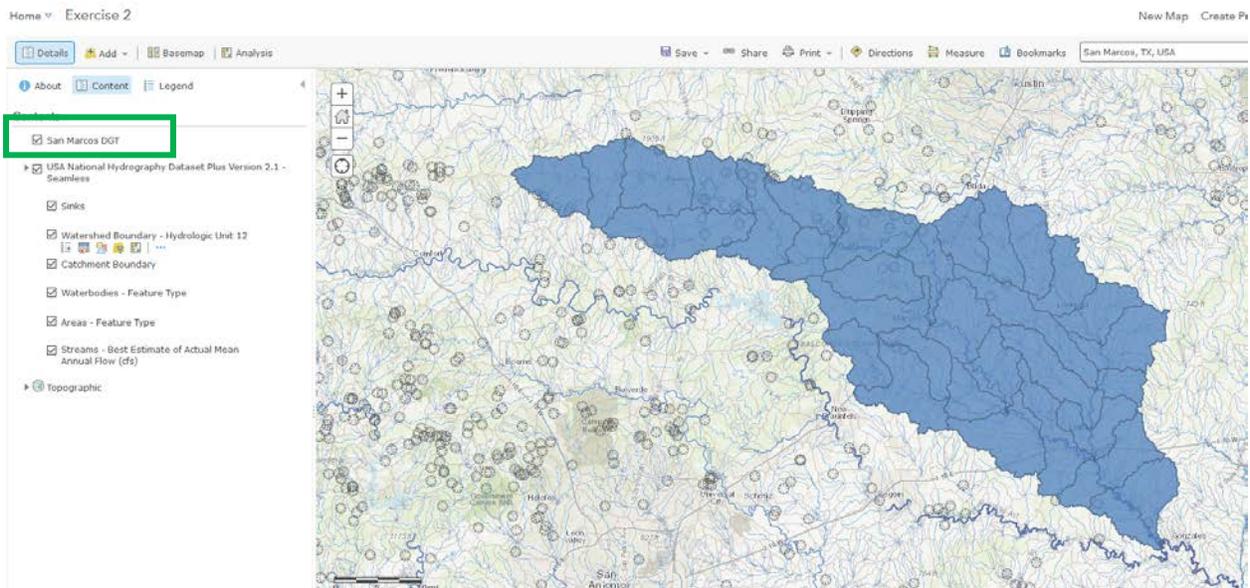
Open the attribute table for San Marcos layer. Note how many features (HUC 12 subwatersheds there are). Click on the Area heading and calculate statistics. Note the average and sum and use these to fill in some of the information being collected.

Let's change the style (symbology) of the layer. Click on the change style button.
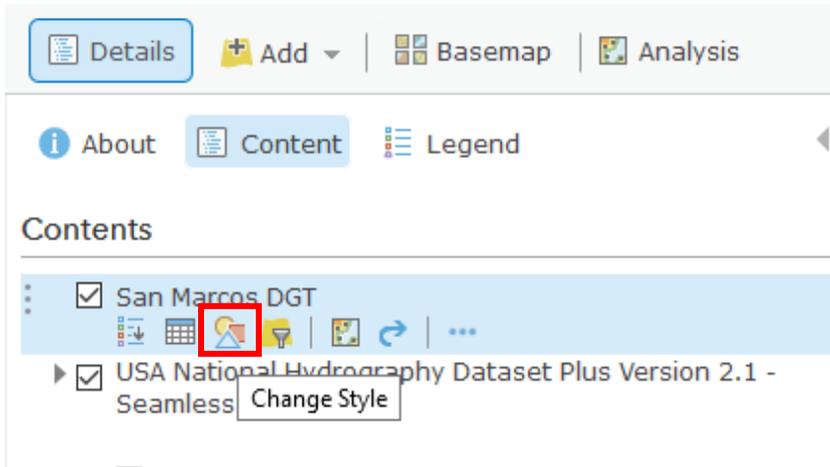
Select HUC 10 Name, Options and Symbols to select the colors to use. Click OK and Done
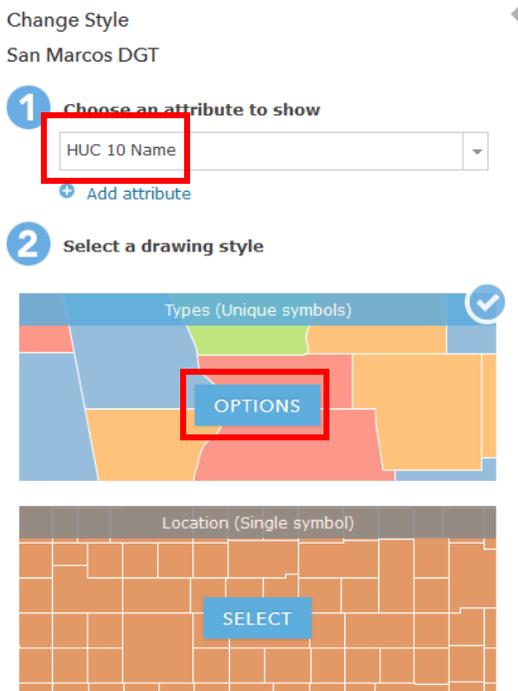
The result is a map with each HUC 10 watershed symbolized in a different color.

If you need to return to where you can see the layers, click on **Details**.
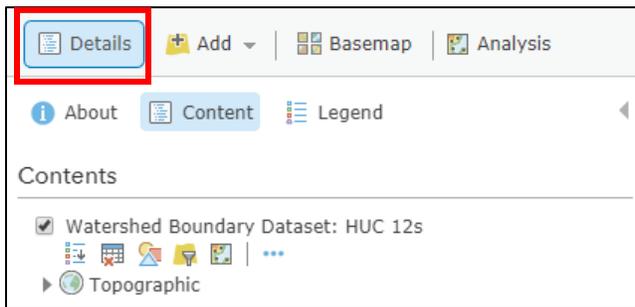
Click on Show Legend to toggle the legend on.
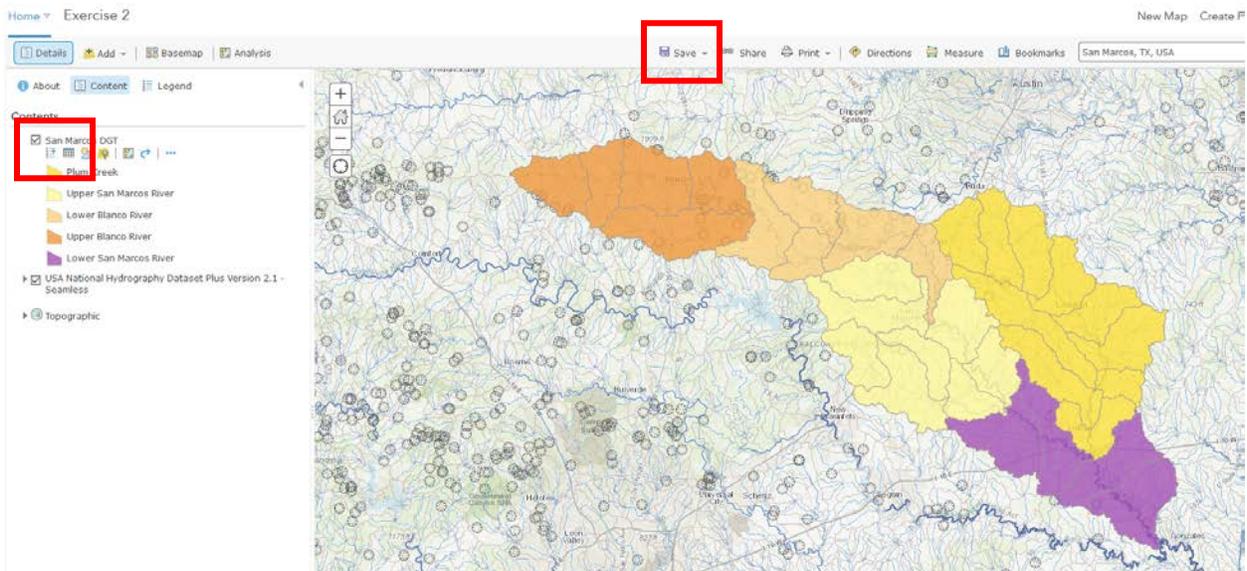
Click **Save** to save your map. You should do this periodically so you do not lose your work if you close your browser.

If you happen to remove the layer from your map you can get it back with the Add button
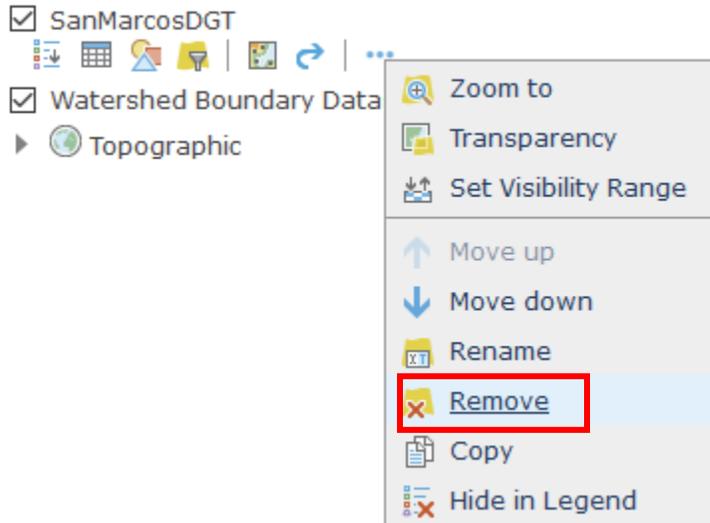
And filtering on My Content
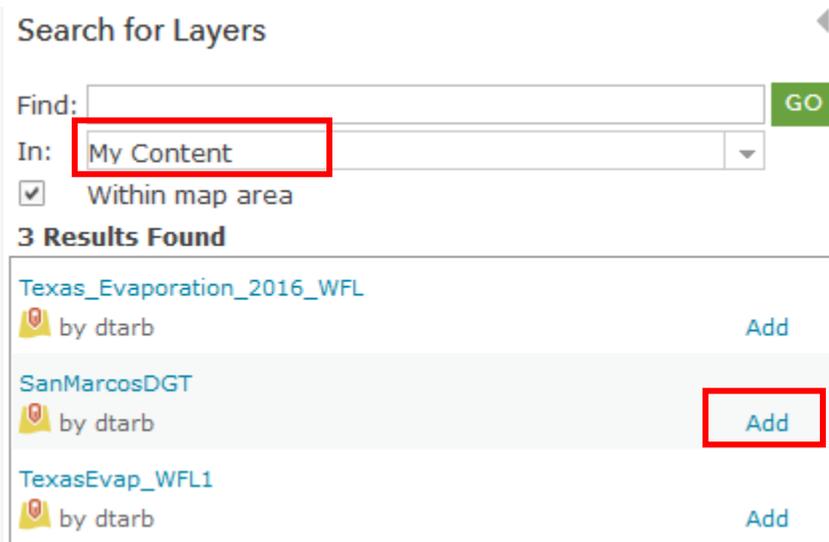
Click on the North-Western subwatershed on the map.
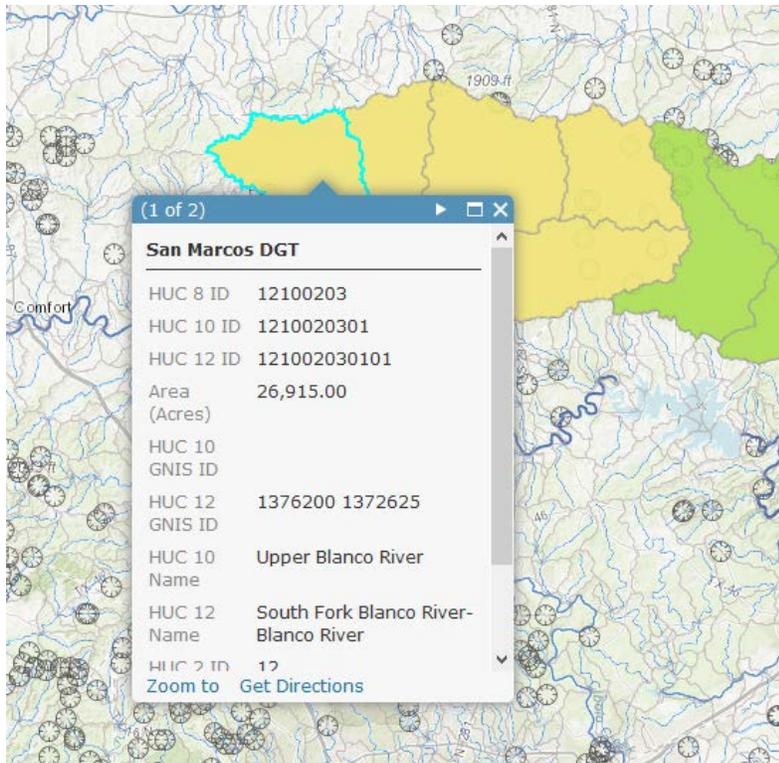
This has HUC 12 ID 121002030101. The position of this in the USGS drainage hierarchy is: Region 12, Subregion 10, Basin 02, Subbasin 03, Watershed 01, Subwatershed 01, thus making the HUC 8 ID 12100203 as we used earlier, and the additional subdivision to the HUC 12 level result in 32 Subwatersheds in this Subbasin.

To Turn in:

1. *A screen shot of your web map showing the San Marcos Subbasin with HUC 10 and HUC 12 watersheds and subwatersheds. Report the following data associated with the San Marcos Subbasin*
   - *Area of San Marcos Subbasin in mi^2*
   - *Number of HUC 12 subwatersheds in San Marcos Subbasin*
   - *Average area of HUC 12 subwatersheds in San Marcos Subbasin in mi^2*
   - *Number of HUC 10 watersheds in San Marcos Subbasin*
   - *Average area of HUC 10 watersheds in San Marcos Subbasin in mi^2*

Creating a San Marcos Basin Boundary (Dissolve to get Subbasin boundary)

Go back to Analysis by either clicking on **Analysis** at the top bar or **Perform analysis** icon below the name of the layer.
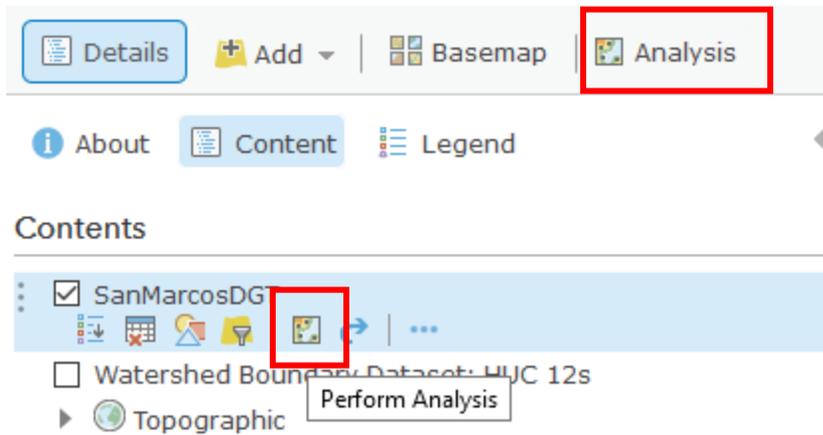
Click on **Manage Data** and choose **Dissolve Boundaries**.
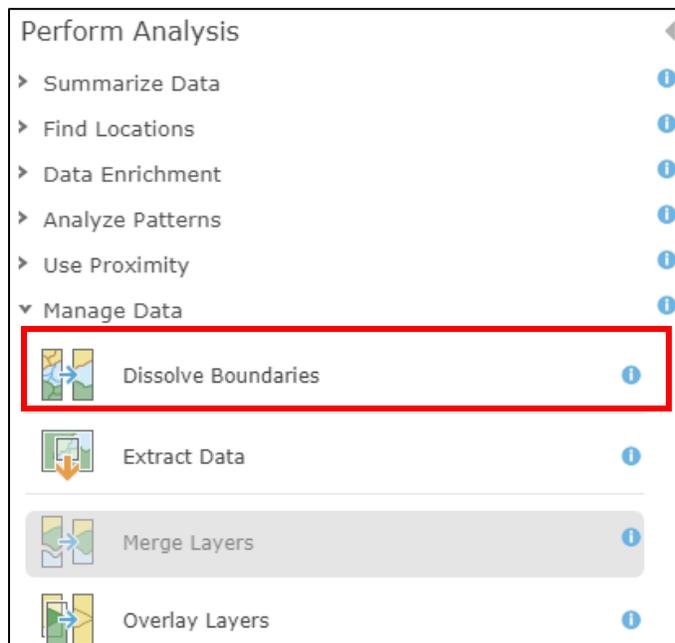
Make sure that in 1 the layer whose boundaries will be dissolved is your San Marcos layer. Keep the default dissolve method and statistic. For Result layer name us a unique name such as SanMarcos Basin Boundary followed by your initials. Uncheck use current map extent and run the analysis.

The result should be a single polygon for the San Marcos Subbasin.
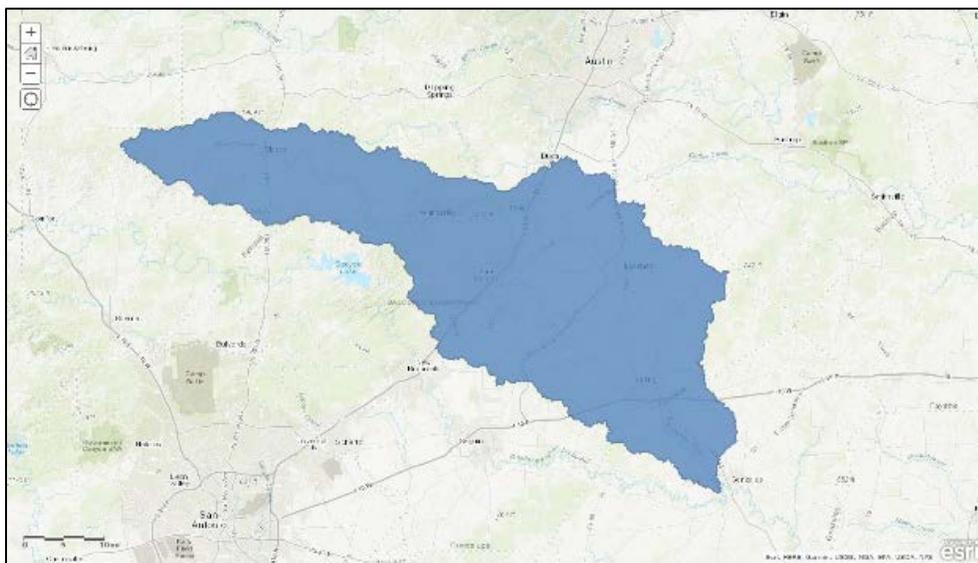
Adjust the Style (symbology) to transparent fill with solid green basin outline
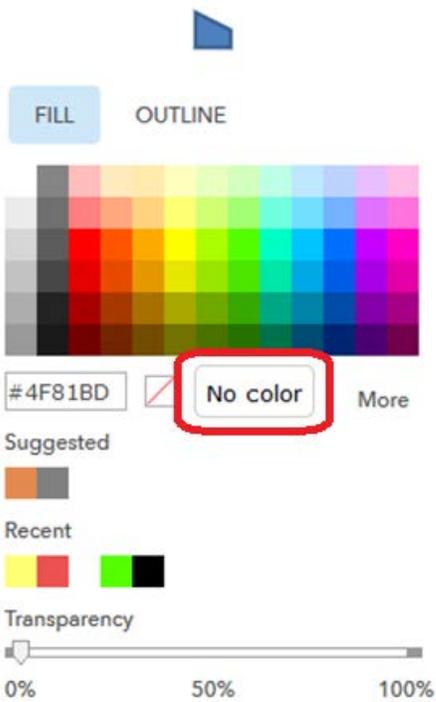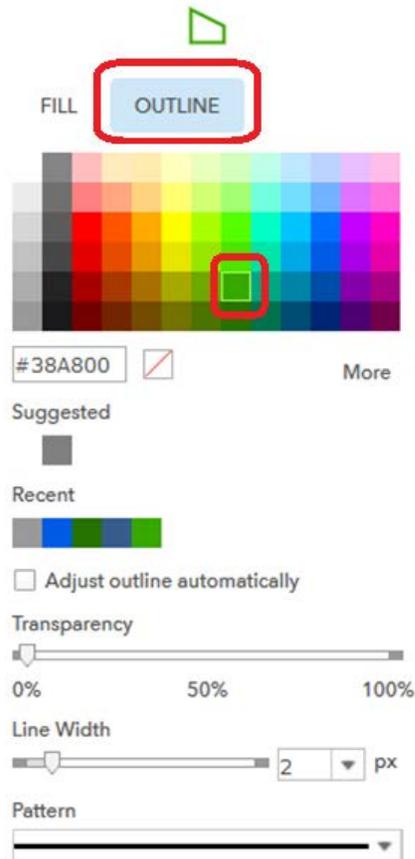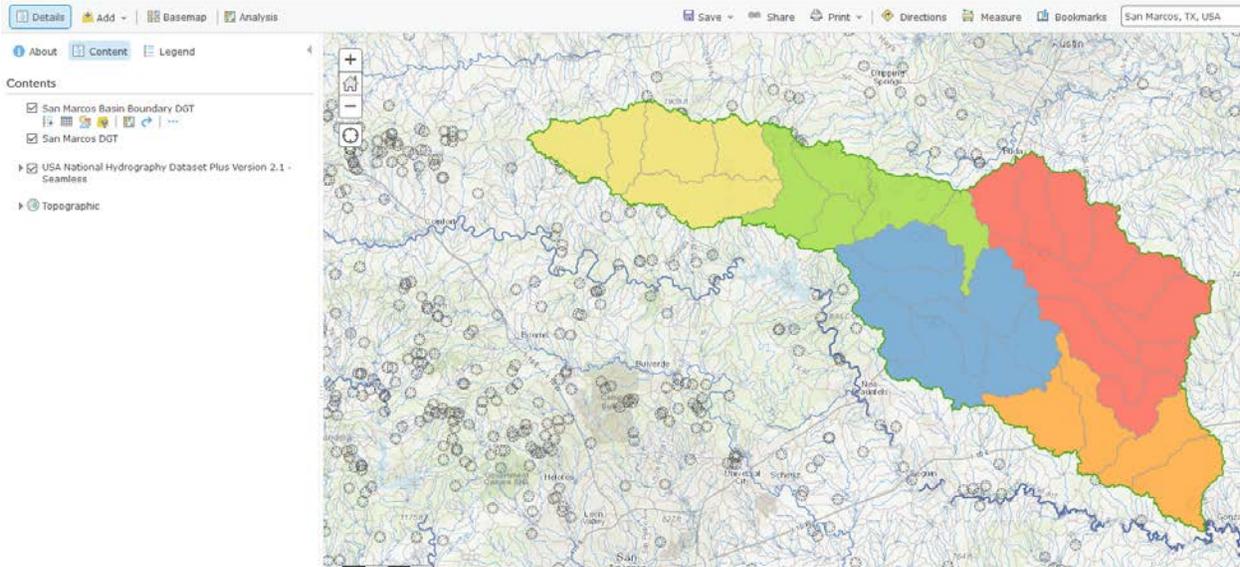
Save your map.

Obtaining the San Marcos Flowlines and Catchments

Now, let's extract flowlines and catchments from the **USA National Hydrography Dataset Plus Version 2.1 – Seamless** layer that we added earlier. This NHDPlus dataset includes **Catchment Boundaries** and **Streams.**
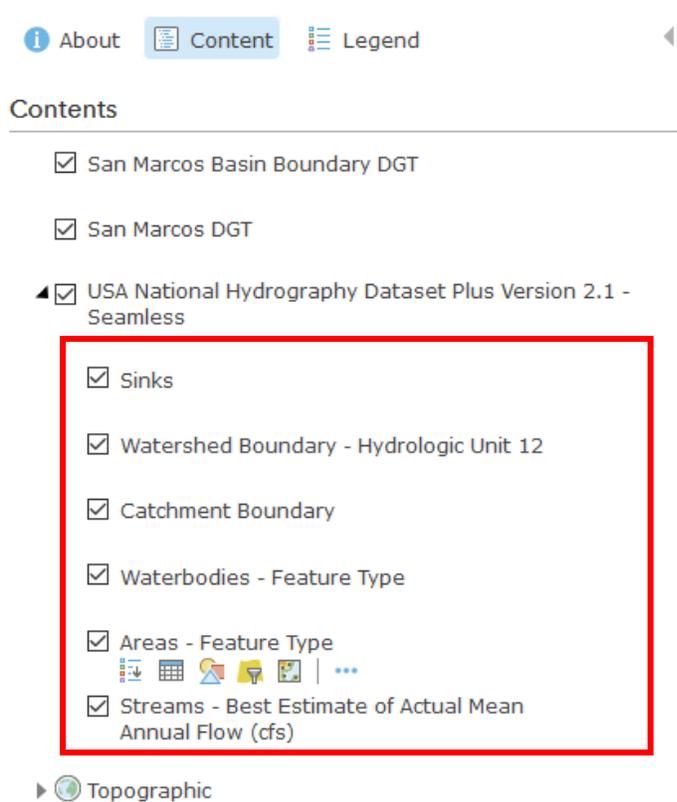
To select the **Streams** that lie within our Basin. Click on the **Perform Analysis** icon below **Streams** feature.
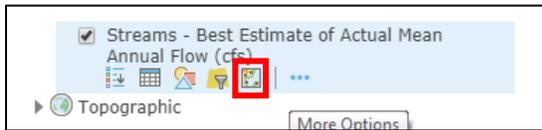
Click the **Find Locations** and then **Find Existing Locations**.

Use the following expression to extract the flowlines that are completely within the San Marcos Basin.

Now, you should be able to see a new layer namely "Flowline" in the content which appears similar to:

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For extracting the catchments, click on perform analysis icon below the Catchment Boundary.
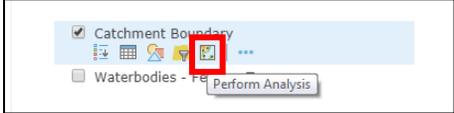
From Find Existing Locations, use the following expression that selects all catchments that intersect with the flowlines.
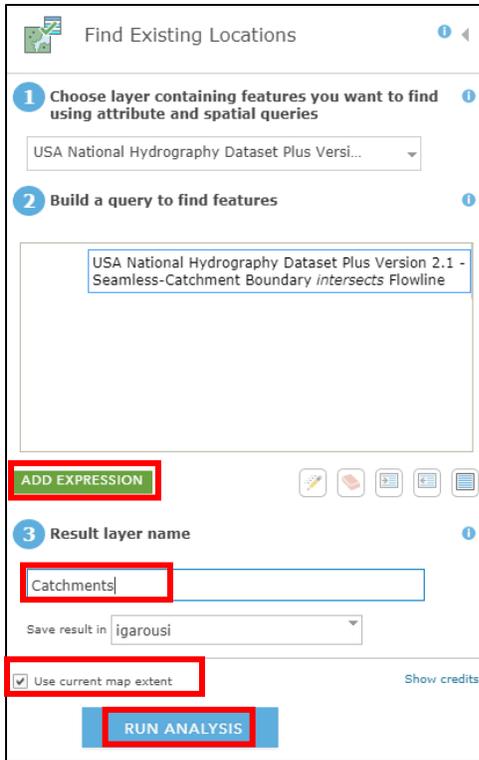
The result should be as follows. You may need to change the style and layer ordering to see the information more clearly.
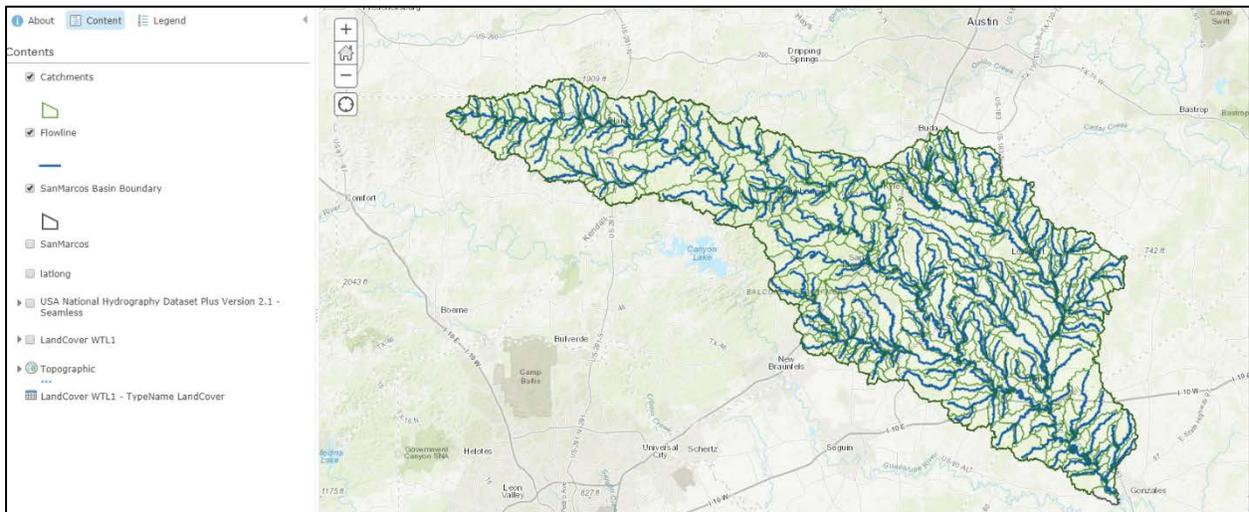
Note that there is a 1:1 relationship between Flowlines and catchments. The flowline Common Identifier (COMID) matches with Catchment Feature ID. It is this connectivity that allows runoff generated from catchments to be linked to stream reaches (flowlines) in the National Water Model.

In this map the streams all look alike, so let's recolor the Flowline according to the **Best Estimate of Actual Mean Flow attribute.** Click on the Change Style icon below Flowline layer.

Select the following:
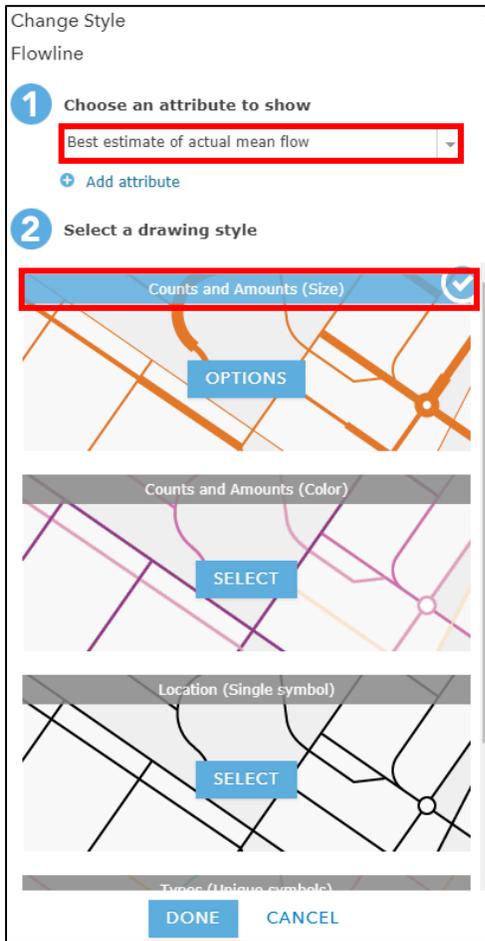
After selecting "Counts and Amounts (Size)", click on OPTIONS. You can change the symbol to blue color. Also, you can define the minimum and maximum size of the line thickness, which is based on the value of mean flow. Streams with higher values of flow are thicker. Check Classify Data to control the precise classes associated with different line thicknesses. Click **OK** and the **DONE**.

Turn on the legend in the contents to get a nice display of the streams symbolized using line width based on actual mean flow.
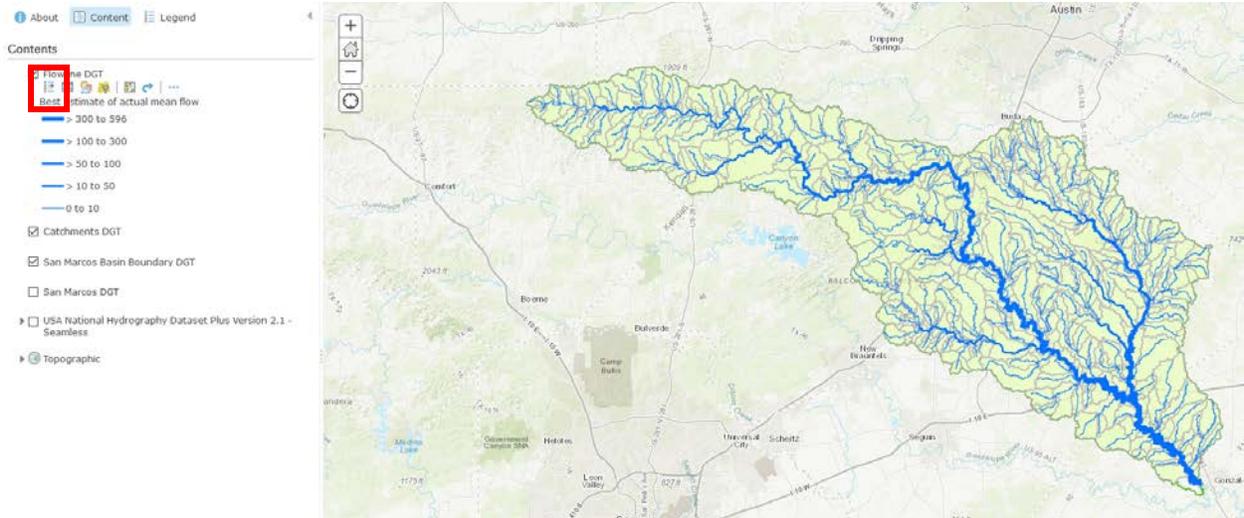
Search for Wimberley at the top right side of the map in the ArcGIS Online.
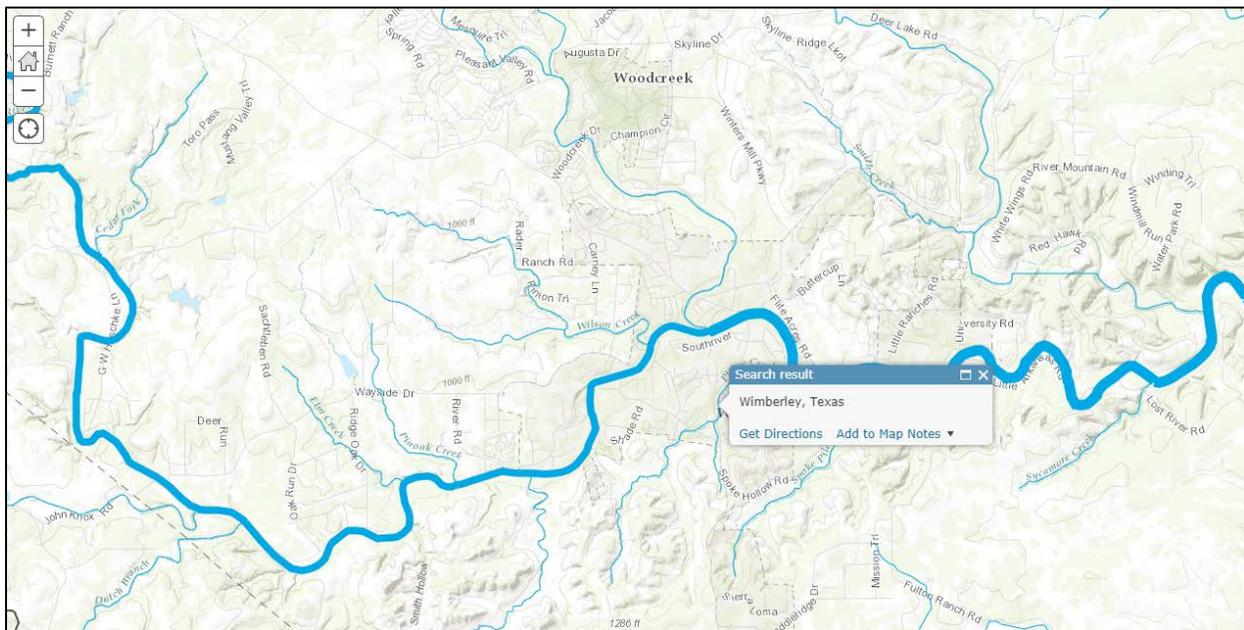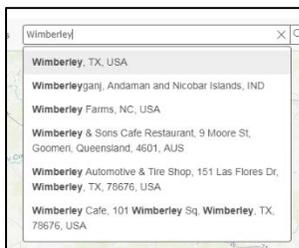
Click on the reach of the Blanco River just downstream of Wimberley.
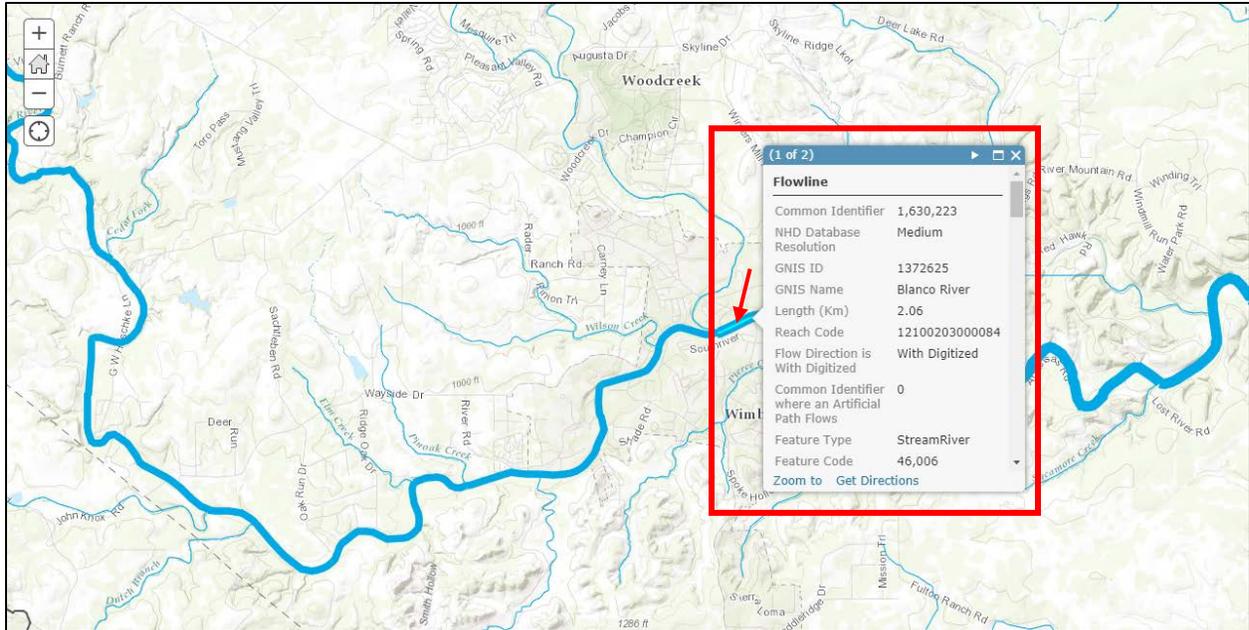
You should see that this reach has a Common Identifier (COMID) = 1630223. If you look at the Catchments layer and click on the catchment within which this flowline is located, you'll see that it has a FeatureID = 1630223.
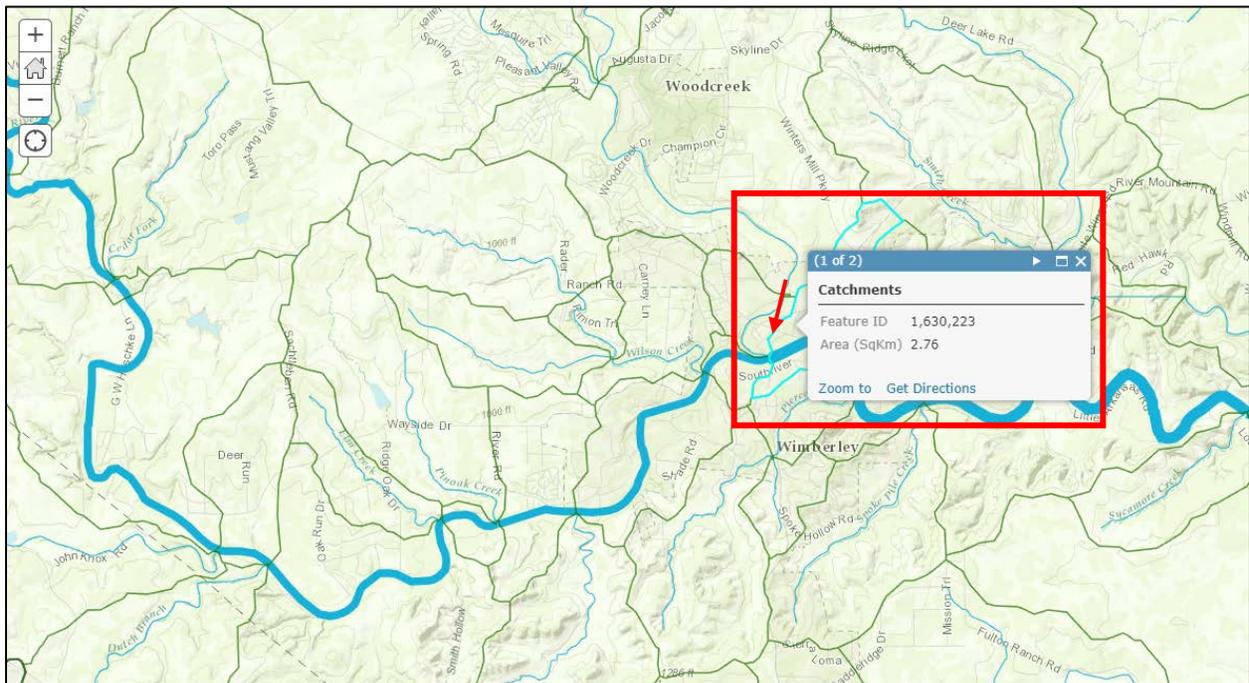
It is this one to one relationship between the COMID of the Flowline and the FeatureID of the Catchment that connects the river and stream segments with their surrounding local drainage areas in the National Water Model.

At this point we have the basemap information we want from the NHDPlus dataset so let's remove this layer from our map and save the map.
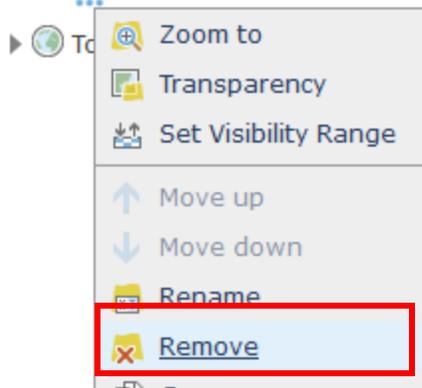
Click **Save** at the top of your map.

Use the attribute tables associated with Flowline and Catchments, and the Statistics calculator on attribute table fields to determine the number and average area of Catchments, and number and average and total length of flowlines. Identify the most downstream reach in the San Marcos Subbasin and determine the best estimate of actual mean flow. Also note the Total upstream catchment area from downstream end of Flowline.

To Turn in:

2. *A screenshot of your web map showing Flowlines symbolized with mean flow, Catchments and San Marcos Basin Boundary. Show legend information for the Flowlines. Report the following data associated with the San Marcos Subbasin Flowlines and Catchments*
   - *Total Area of San Marcos Subbasin determined from summing Catchment areas as well as from the most downstream flowline in mi^2. Comment on any differences and any differences with the area reported in #1 above.*
   - *Number of NHDPlus Catchments in San Marcos Subbasin*
   - *Average area of NHDPlus Catchments in San Marcos Subbasin in mi^2*
   - *Number of NHDPlus flowlines in San Marcos Subbasin*
   - *Average length of NHDPlus flowlines in San Marcos Subbasin in mi*
   - *Total length of NHDPlus flowlines in San Marcos Subbasin in mi*
   - *Best estimate of actual mean flow at the outlet of the San Marcos Subbasin in cfs.*
   - *Common Identifier (COMID) of the Flowline at the outlet of the San Marcos Subbasin*

Extracting Main Rivers

There are three main rivers in the San Marcos Subbasin. These are the Blanco River, San Marcos River and Plum Creek. Let's create a Main Rivers layer. To do so, click on perform analysis below the Flowline layer and then select **Find Existing Locations**. Define three expressions to query for GNIS Name to be "Blanco River" or "San Marcos River" or "Plum Creek".

Add Expression

Flowline	⌄	where (attribute query) ⌄

GNIS Name ⌄	is ⌄	Blanco River
		⦿ Value ◯ Field ◯ Unique

ADD CLOSE

Add Expression

Flowline	⌄	where (attribute query) ⌄

GNIS Name ⌄	is ⌄	San Marcos River
		⦿ Value ◯ Field ◯ Unique

ADD CLOSE

Add Expression

Flowline	⌄	where (attribute query) ⌄

GNIS Name ⌄	is ⌄	Plum Creek
		⦿ Value ◯ Field ◯ Unique

ADD CLOSE

By default, when you add multiple expressions, "and" is used which means that all three conditions need to be satisfied in the collection. Here click on each "and" to switch it to "or" which means that only one of the conditions need to be satisfied and will generate a result where the name is one of the three queried.

The result is:
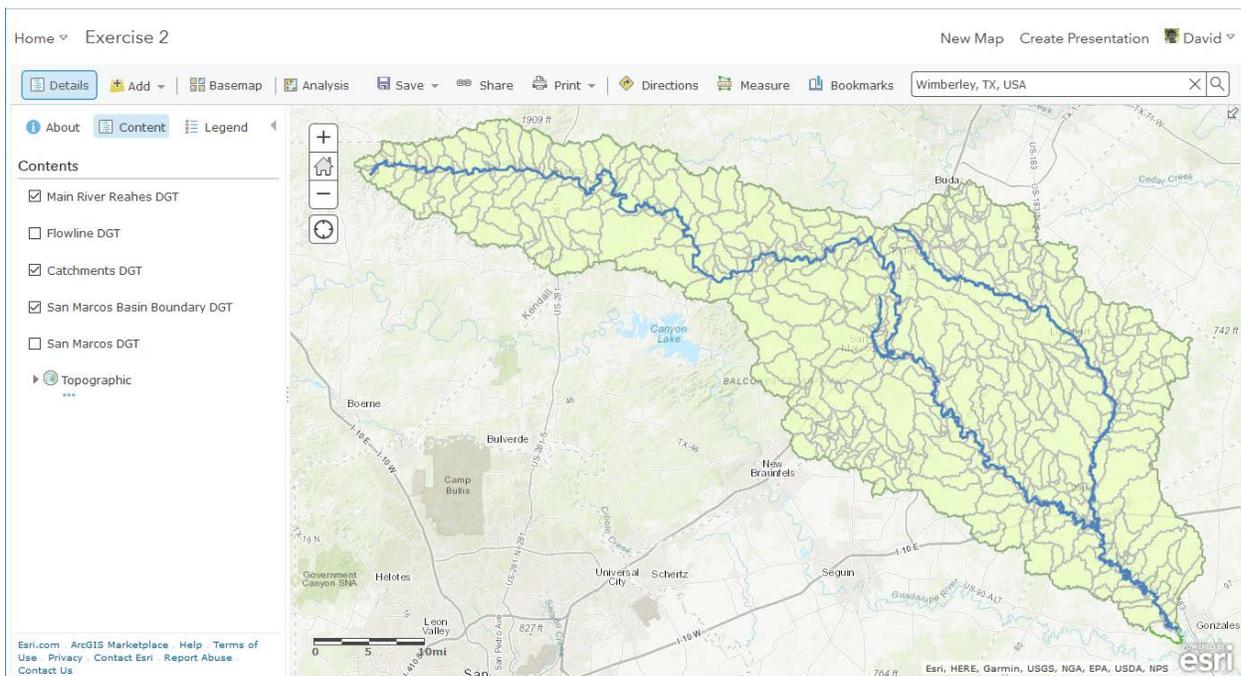
Change the symbology so that each river is shown with a different color. Click on Change style icon below the new layer.
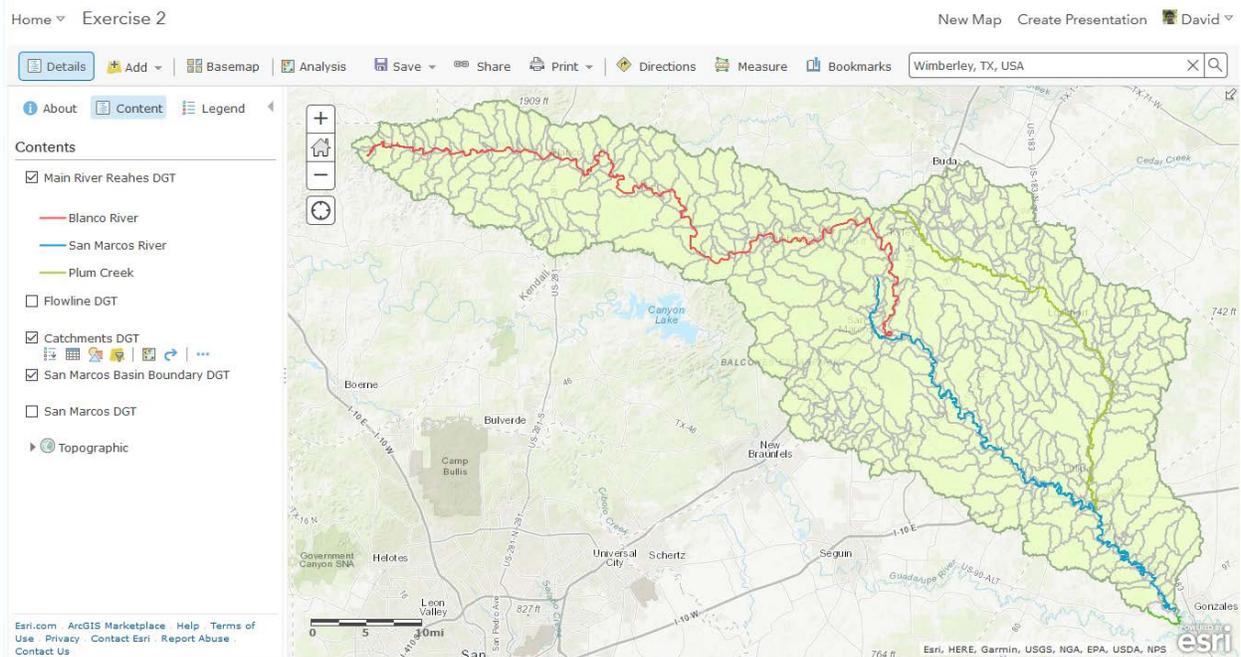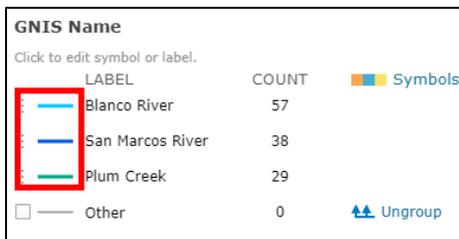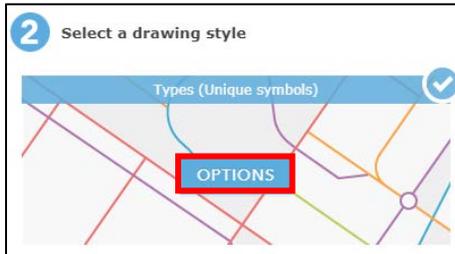
Now let's add Map Notes to label each river. From "Add", select "**Add Map Notes**".

Add Map Notes   ✕

Name: RiverName

Template: Map Notes

Use Map Notes to create basic shapes in a wide variety of applications.

CREATE   CANCEL

Click create and then you will see the following. Click on Text and then click on a proper location on the map to add the text.

Save your map.

To Turn in:

3. *A screen shot of your web map showing the three main rivers with labels in the San Marcos Subbasin*

Creating a Point Feature Class of Stream Gauges

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

Using Excel develop a table containing SiteID, Latitude (as lat) and Longitude (as long) coordinates of the gauges. Save this in a file named **latlong.csv**. You will need to evaluate decimal degrees from the degree, minute and second information.

	A	B	C	D	E	F	G	H	I	J	K	L
1	SiteID	SiteName	LatDeg	LatMin	LatSec	LongDeg	LongMin	LongSec	LatDD	LongDD	DASqMile	MAFlow
2	8171000	Blanco Rv	29	59	39	98	5	19	29.99417	-98.0886	355	142
3	8171300	Blanco Rv	29	58	45	97	54	35	29.97917	-97.9097	412	165
4	8172400	Plum Ck a	29	55	22	97	40	44	29.92278	-97.6789	112	49
5	8173000	Plum Ck n	29	41	58	97	36	12	29.69944	-97.6033	309	114
6	8172000	San Marcc	29	39	58	97	39	2	29.66611	-97.6506	838	408
7	8170500	San Marcc	29	53	20	97	56	2	29.88889	-97.9339	48.9	176

In your Exercise 2 web map on ArcGIS Online select Add button and choose "**Add Layer from File**". Navigate to your latlong.csv file and import it.

Add Layer from File

Locate the file you want to import.

- Shapefile (ZIP archive containing all shapefile files)
- CSV or TXT files with optional address or latitude, longitude (comma, semi-colon or tab delimited)
- GPX (GPS Exchange Format)

File: [Browse...] latlong.csv

Note: You can import shapefiles and CSVs with 1000 features. No feature limits on GPX files.

Tip: You can also drag and drop a CSV or GPX file from your desktop onto your map.

[IMPORT LAYER]   CANCEL

Note that when you add a CSV file with location information (street addresses or latitude-longitude coordinates), the features can be located on the map. If you add a CSV file that doesn't contain location information, a table is added instead. In this case, the file contains latitude-longitude coordinates. Use the Add CSV Layer window to set LatDD and LongDD as Latitude and Longitude fields and click Add Layer

The system then gives you the option to adjust symbology. Here I used unique symbols based on Site Name.
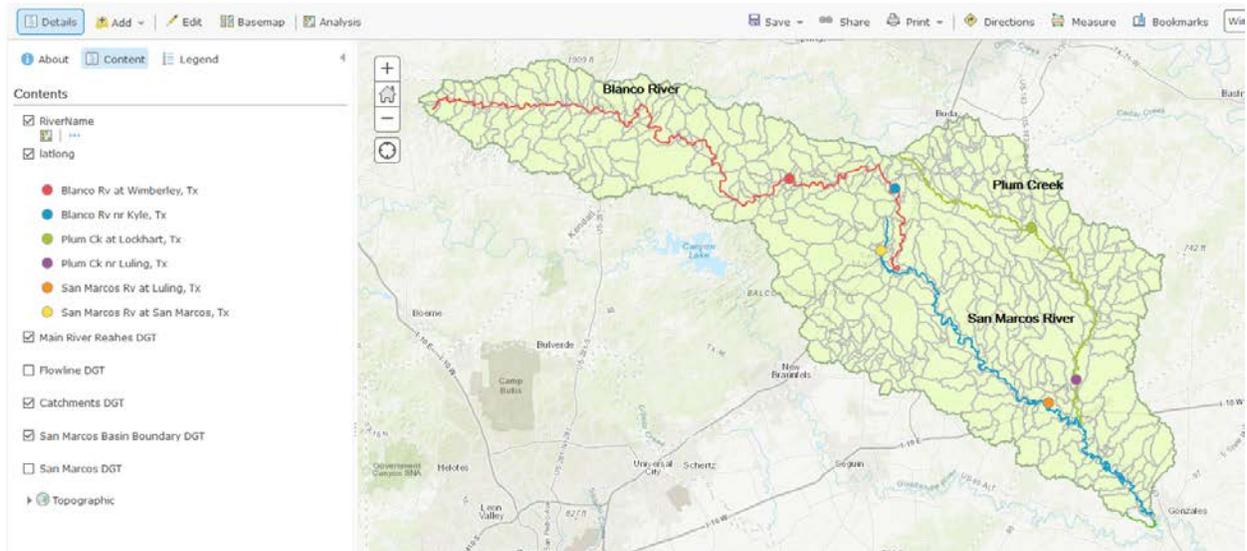
Create Labels for the latlong layer may be used to label each point with its Name. Click on More Options "..." then Create Labels for latlong, to add these labels.
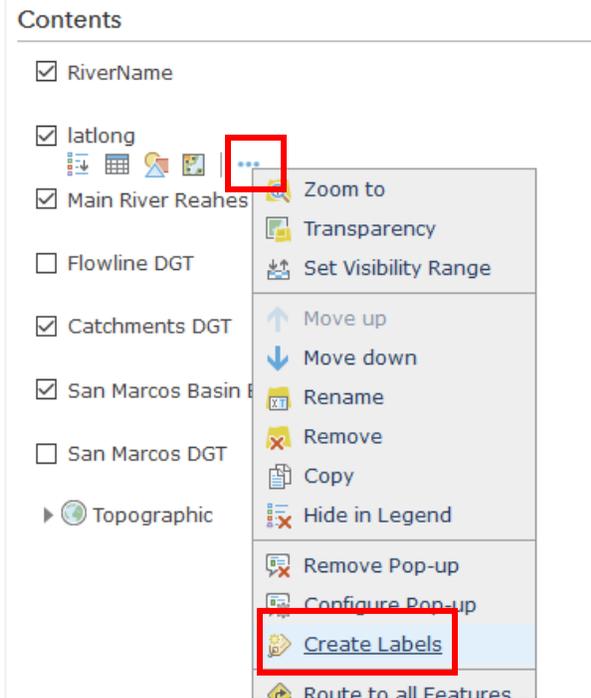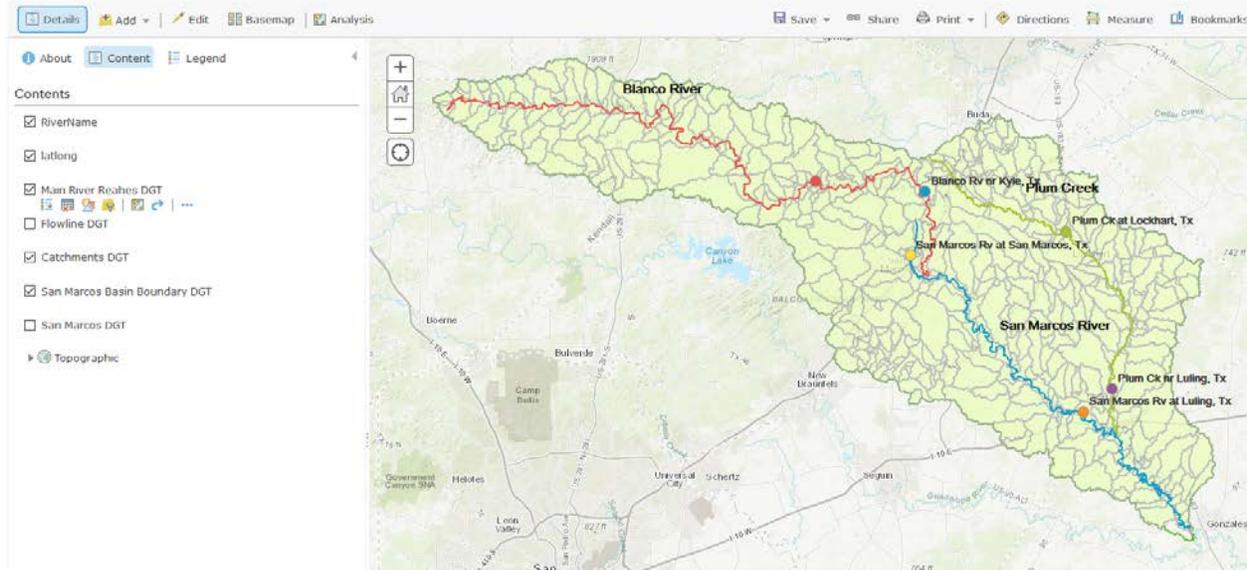
Save your map.

Zoom in on each stream gauge and identify the nearest NHDPlus flowline and record its best estimate of actual mean flow (cfs) Fill out the following table. Note that NHDPlus area values are in km^2 so you will need to do km to mi conversions. 1 mi = 1.60934 km. 1 mi^2 = 2.59 km^2

Site ID	Site Name	Drainage Area (mi^2)	MAFlow (cfs)	NHDPlus Reach COMID for reach nearest to the stream gauge	NHDPlus best estimate of actual mean flow (cfs)	NHDPlus Total upstream catchment area from downstream end of Flowline (mi^2)
08171000	Blanco Rv at Wimberley, Tx	355	142			
08171300	Blanco Rv nr Kyle, Tx	412	165			
08172400	Plum Ck at Lockhart, Tx	112	49			
08173000	Plum Ck nr Luling, Tx	309	114			
08172000	San Marcos Rv at Luling, Tx	838	408			
08170500	San Marcos Rv at San Marcos, Tx	48.9	176			

Comment on any differences that seem out of the ordinary or larger than common uncertainty or numerical calculation accuracy.

To turn in

4. *A screen shot of your web map showing the labeled stream gauges and the table above with quantities filled in and interpretive comments on differences.*

We are done with the web map, so close the browser with Exercise 2 map.

Land Cover Information for the San Marcos Basin

Up to this point the necessary data has all been obtained from the Living Atlas using ArcGIS online mapping functionality. Online functionality for working with raster data is limited, so here we will switch to ArcGIS Pro on the desktop and add to our base map raster Land Cover data downloaded from the National Map.

Open ArcGIS Pro and create a Blank project.
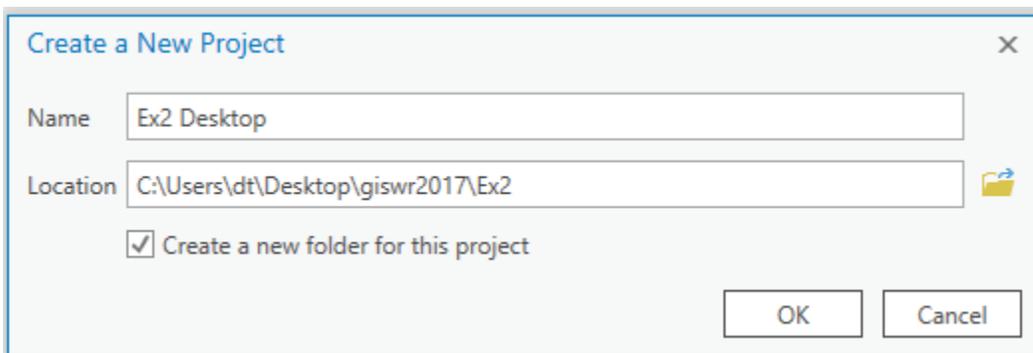
I used the name Ex2 Desktop so I can tell which project is from the desktop and which from the web.

Under Portal My Content locate your Exercise 2 Web Map and Right Click to Add and Open. Note that this should be with the Catalog View active, not while you are looking at a map, so be sure you start from a blank project, not a map project.
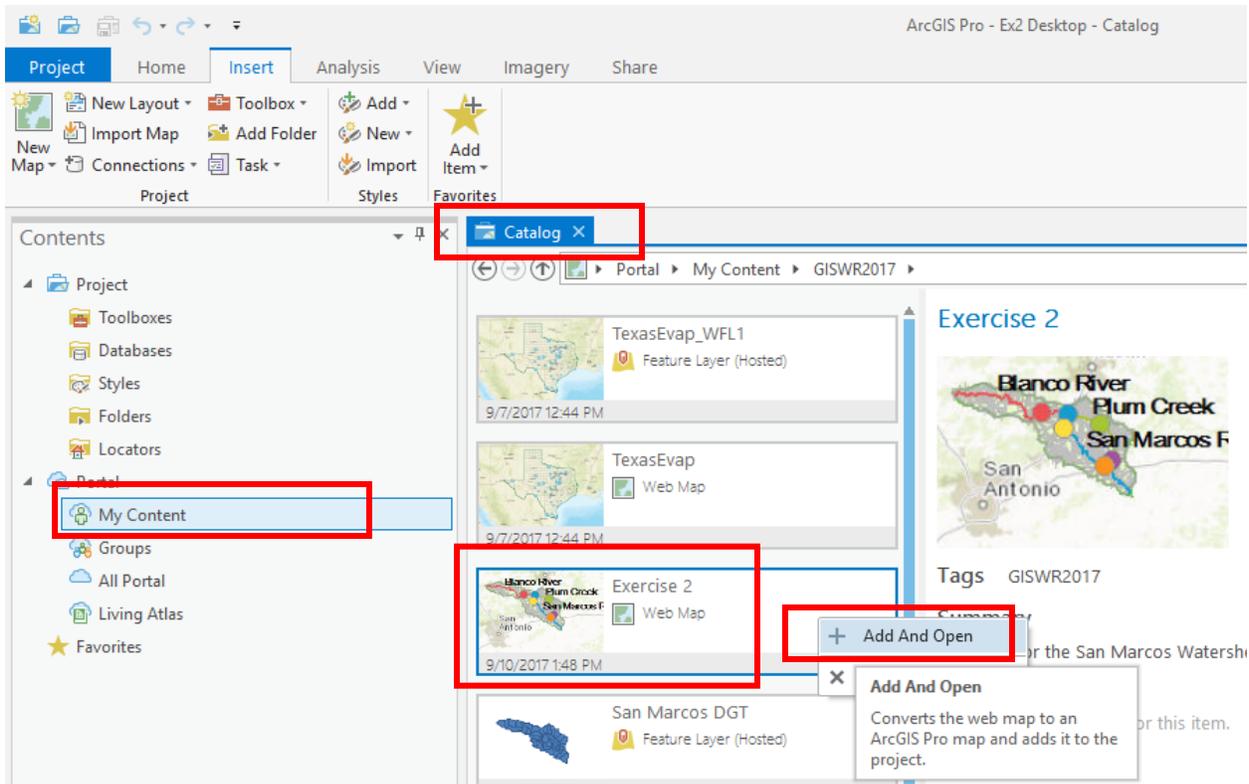
You should see that ArcGIS Pro opens with a replica of your web map in the Desktop Software. Pretty Slick! This is an example of the interoperability between web and desktop software.

Let's obtain Land Cover Information from the National Map. Go to
https://viewer.nationalmap.gov/launch/

Click on Download GIS Data in the GIS Data box.

In the Search location box enter San Marcos and from the choices pick San Marcos, Texas.
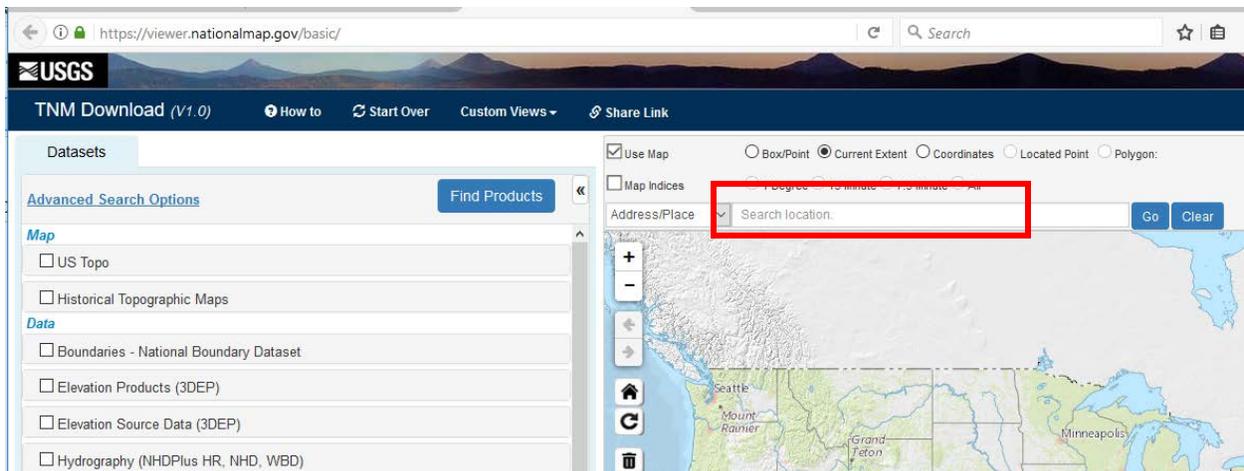
The Map should zoom to San Marcos. With the Use Map check box set this serves to focus the search in the map area. Now in the panel on the left select National Land Cover Database and State, then click on Find Products
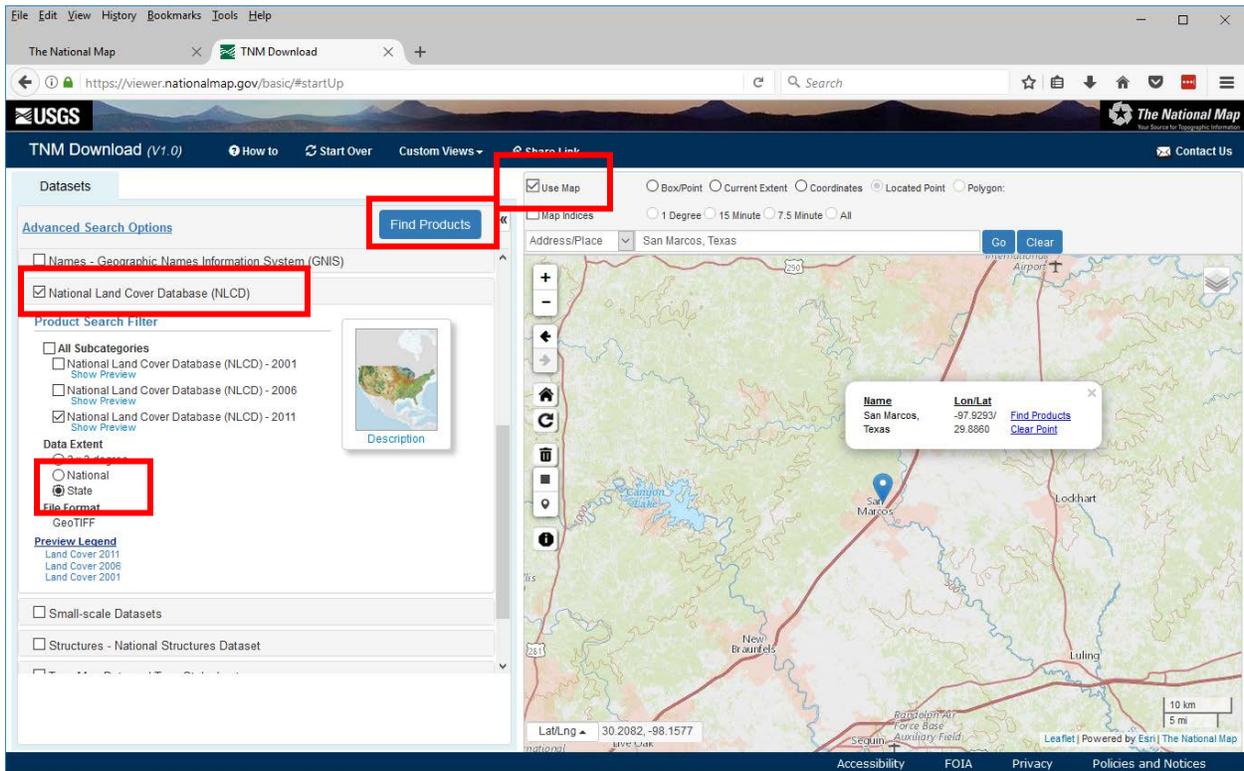
Three products should be shown in the left side. Click on Download for the NLCD 2011 Land Cover option.

Unzip the file downloaded into a convenient location. Locate the file NLCD2011_LC_Texas.tif and load this into your ArcGIS Pro Map. (You may need to attach the folder to find it). I loaded the file by dragging from the Catalog pane. Zoom to the extent of the layer to see that you have Landcover data for the whole of Texas.

Now use Geoprocessing to extract the data just for the San Marcos Subbasin, using the San Marcos Basin Boundary. Click on Analysis, Tools to activate the Geoprocessing pane
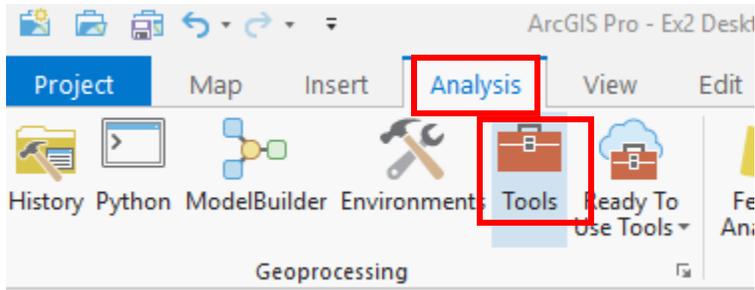
In the Geoprocessing pane (to the right) enter "extract" in Find Tools
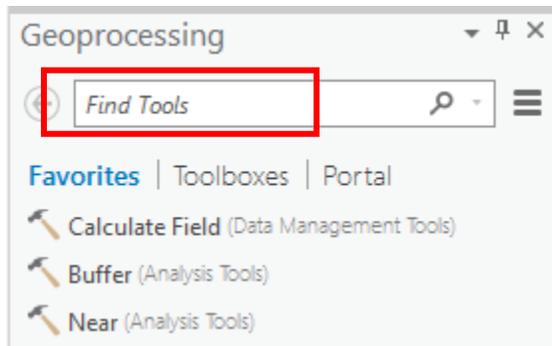
Open the Extract by Mask Tool
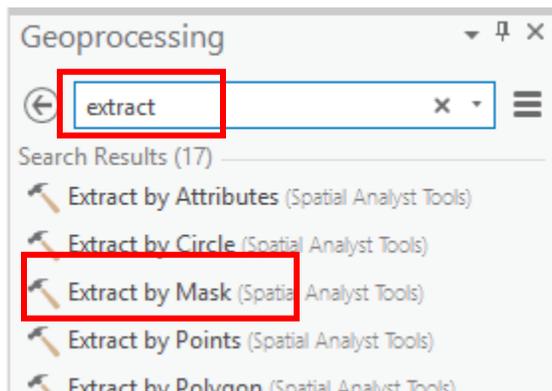
Use the following inputs and save the results as LandCover in your Desktop project geodatabase.
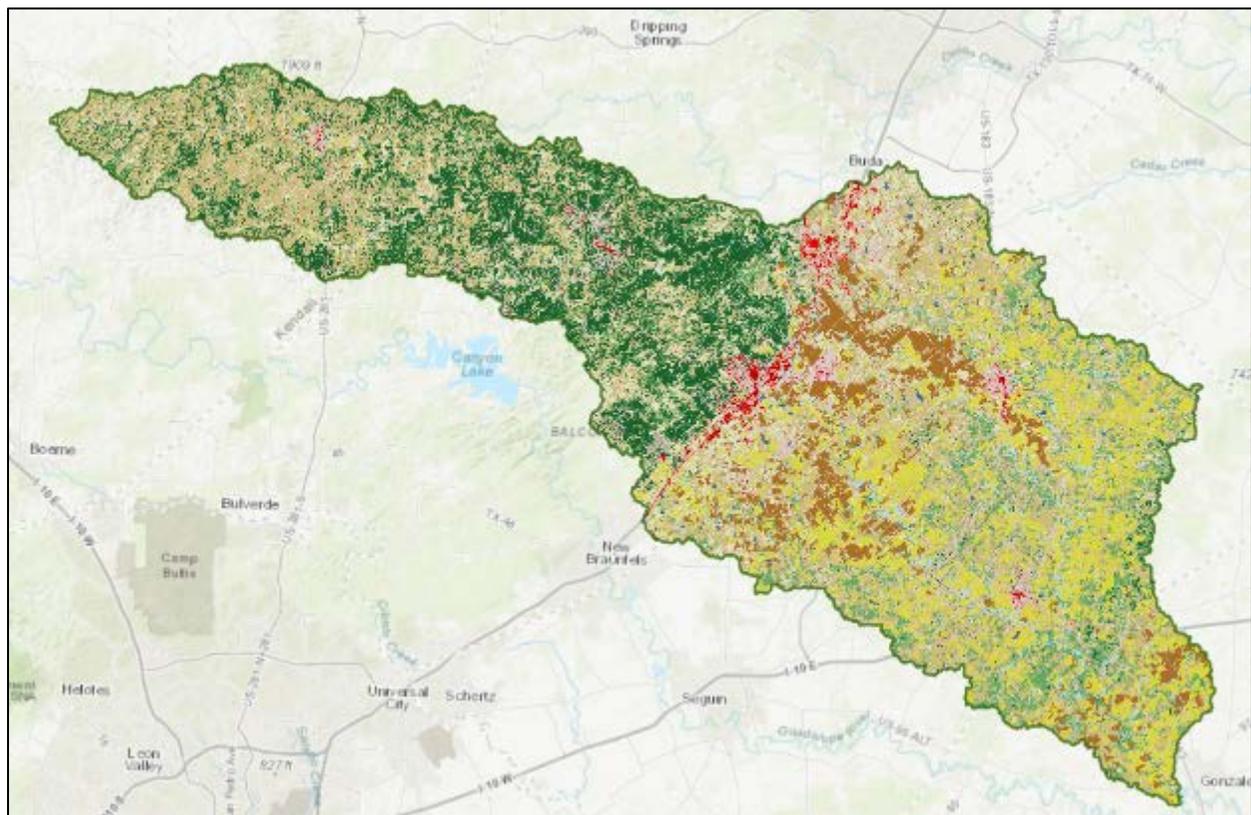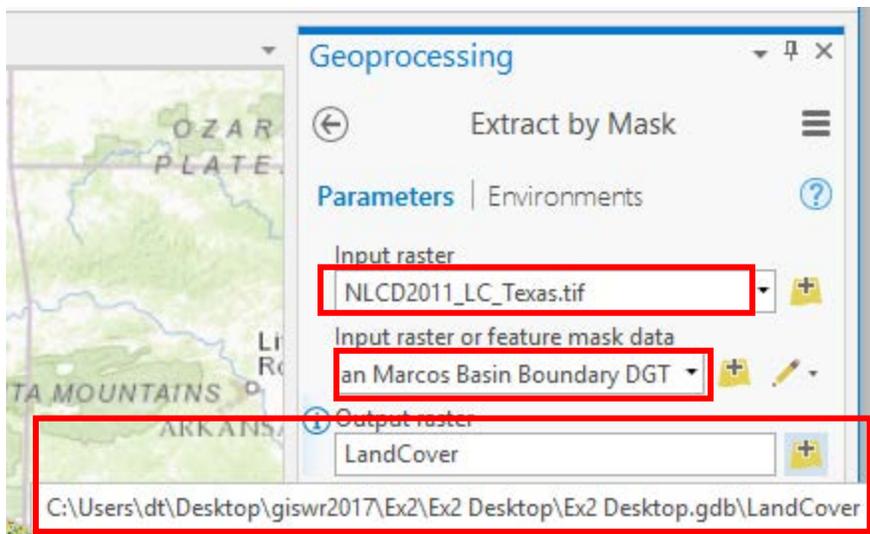
If you right click on the LandCover raster and open its properties, and then select Raster Information, you'll see it is a raster with 30m X 30m cells (these are derived from 30m Landsat imagery).
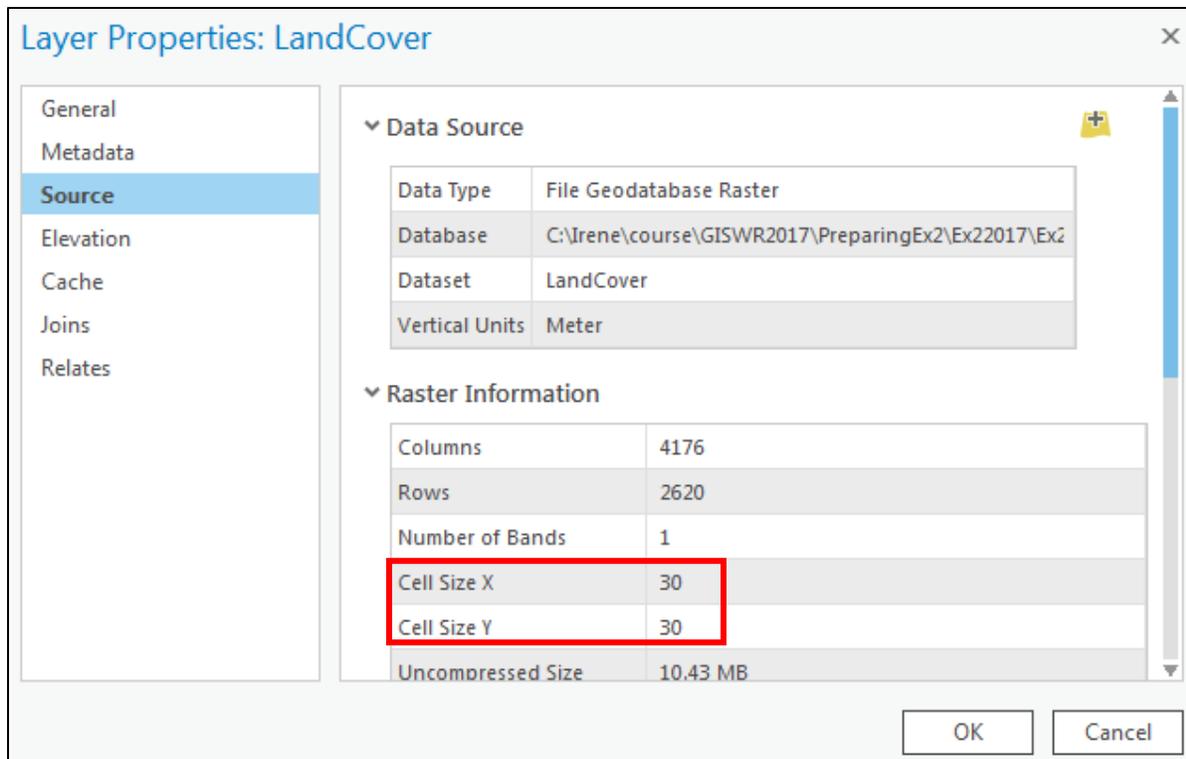
Because this is an integer grid, it has a Value Attribute Table (grids with real numbers do not have a VAT). Right click to open the Attribute Table
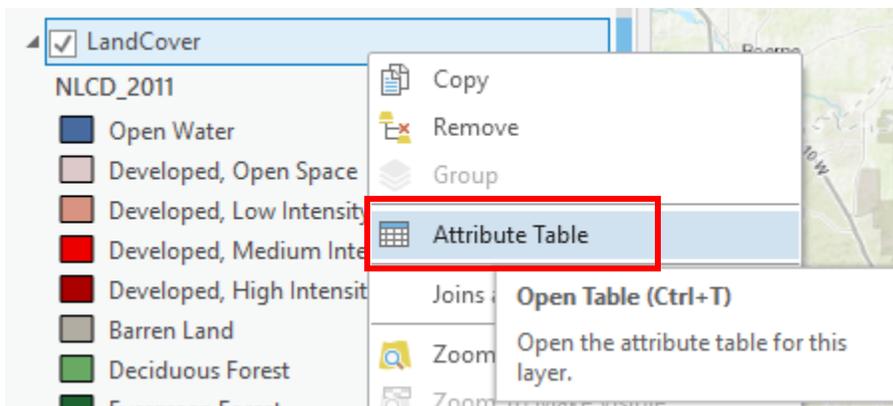
This shows the land cover classes indicated by Value color band encoding and text description. The Count indicates the number of cells having that Value.

OBJECTID	Value	Count	Red	Green	Blue	NLCD_2011	Opacity
2	11	17181	0.278431	0.419608	0.627451	Open Water	1
3	21	297569	0.866667	0.788235	0.788235	Developed, Open Sp...	1
4	22	43188	0.847059	0.576471	0.509804	Developed, Low Inte...	1
5	23	22738	0.929412	0	0	Developed, Medium...	1
6	24	9654	0.666667	0	0	Developed, High Inte...	1
7	31	9018	0.698039	0.678431	0.639216	Barren Land	1
8	41	429926	0.407843	0.666667	0.388235	Deciduous Forest	1
9	42	533502	0.109804	0.388235	0.188235	Evergreen Forest	1
10	43	32111	0.709804	0.788235	0.556863	Mixed Forest	1
11	52	1215316	0.8	0.729412	0.486275	Shrub/Scrub	1
12	71	461317	0.886275	0.886275	0.756863	Herbaceuous	1
13	81	531960	0.858824	0.847059	0.239216	Hay/Pasture	1
14	82	234548	0.666667	0.439216	0.156863	Cultivated Crops	1
15	90	70838	0.729412	0.847059	0.917647	Woody Wetlands	1
16	95	2148	0.439216	0.639216	0.729412	Emergent Herbaceuo...	1

0 of 15 selected

Suppose, for the purposes of simplification we are interested in aggregating the landcover into fewer classes

1. Water and Wetlands (11,90,95)
2. Developed (21-24)
3. Forest (41-43)
4. Agriculture (71-82)
5. Shrub and Barren (31 and 52)

This requires reclassifying the LandCover raster. In Geoprocessing search for reclassify and then choose **Reclassify (Spatial Analyst Tools)**.
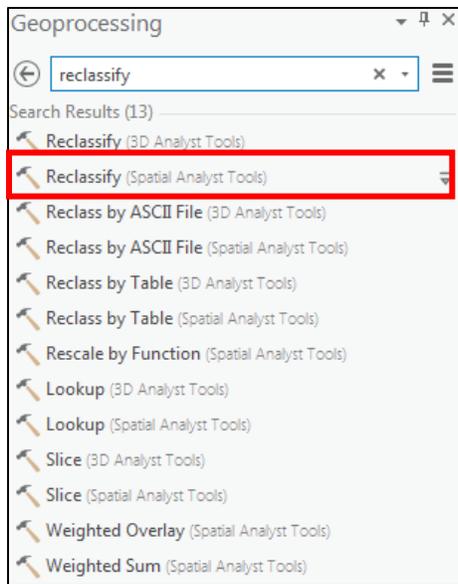
Set the inputs as follows and Run.
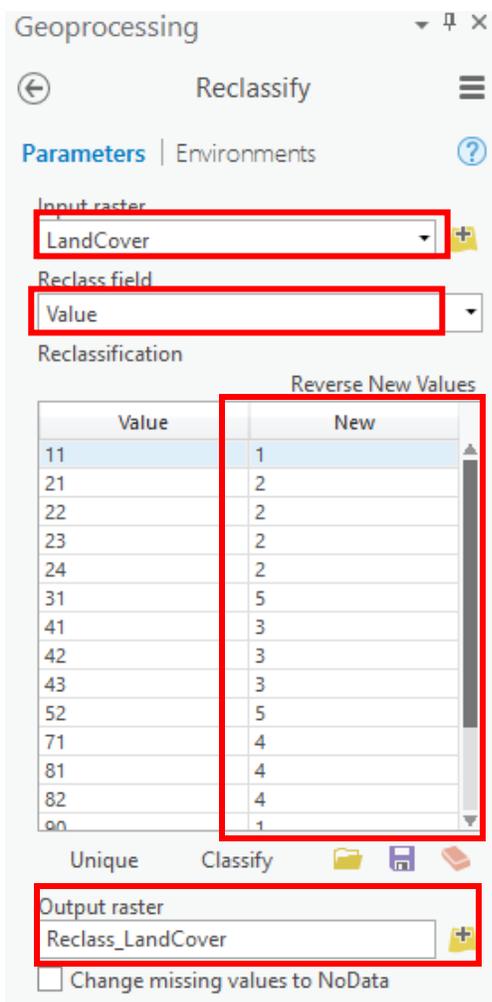
You should see the reclassified land cover layer, classified into five values.
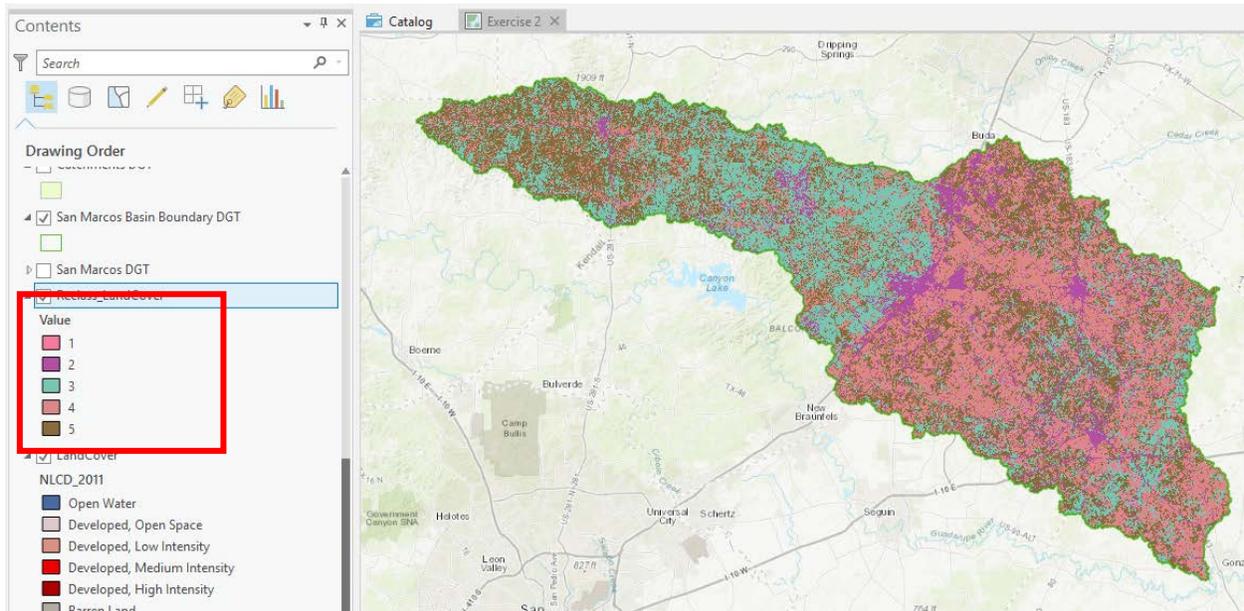
To provide text definitions for these simplified land classes use Excel to create a csv file that has

Value	LandCover
1	Water and Wetlands
2	Developed
3	Forest
4	Agriculture
5	Shrub and Barren

Use Add Data to the Map to add this to ArcGIS Pro. Then for the Reclass_LandCover layer on the map select Joins and Relates, Add Join.
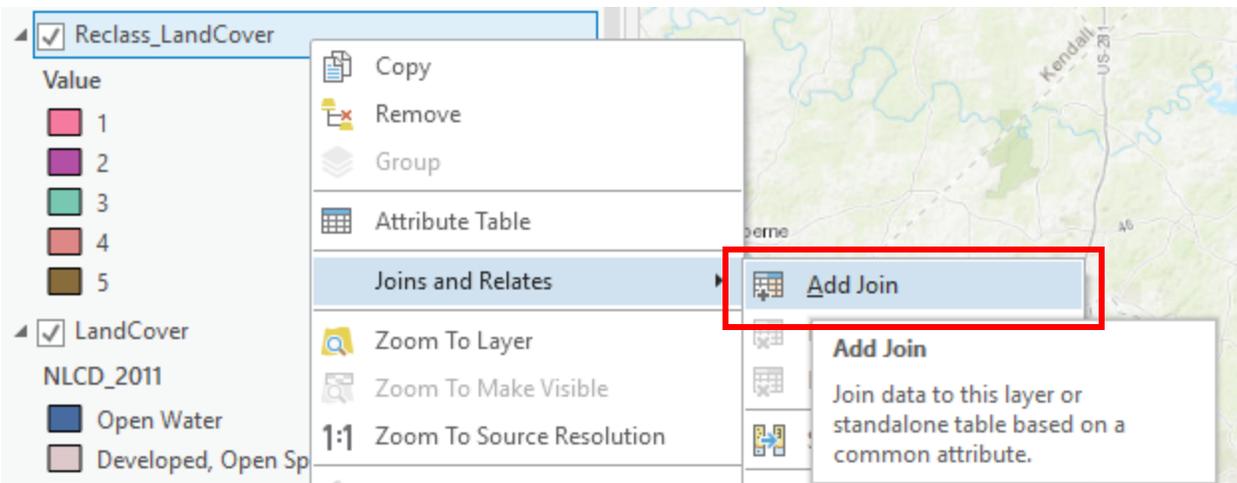
In the Geoprocessing pane set the Add Join Parameters as follows and click Run
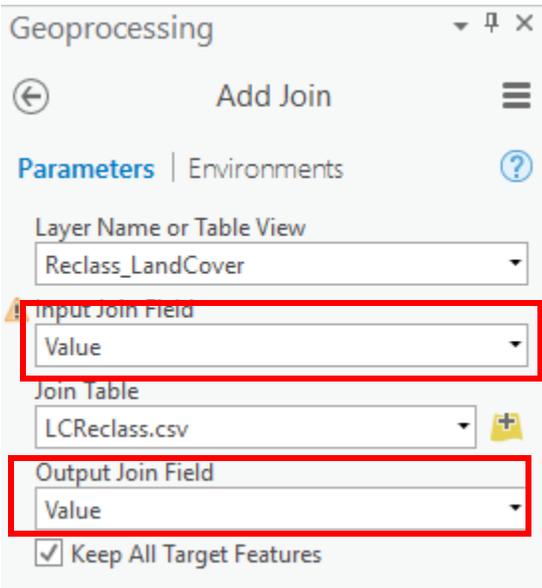
If you open the attribute table for Reclas_LandCover you should see:

OBJECTID	Value	Count	Value	LandCover
1	1	90166	1	Water and Wetlands
2	2	373151	2	Developed
3	3	995545	3	Forest
4	4	1227829	4	Agriculture
5	5	1224330	5	Shrub and Barren

However, the new landcover definitions are not permanently part of the Reclass_Landcover value attribute table (VAT). They are temporarily associated through the join. To write them into the Reclass_Landcover VAT create a new field. In the Table View click Add Field
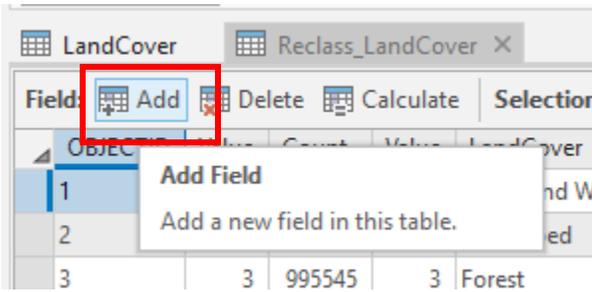
Enter field Name "LandCover and Data Type "Text". You may need to tab between entries.
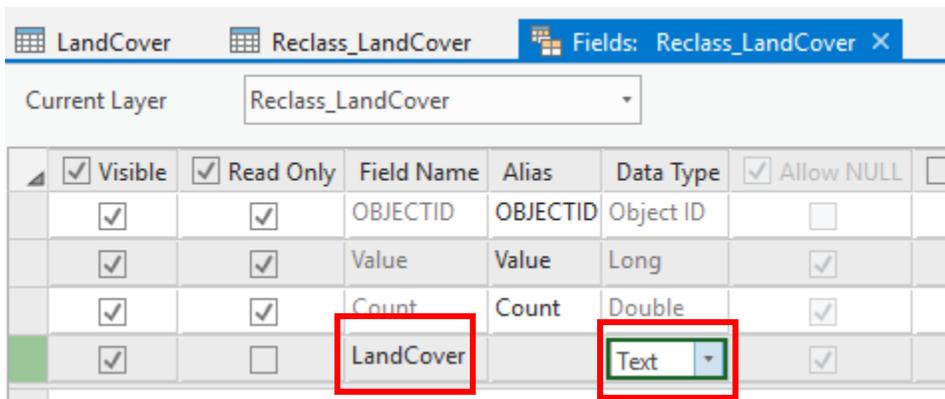
Click on Save at the top in the Fields tab to make this permanent, then close the fields view.
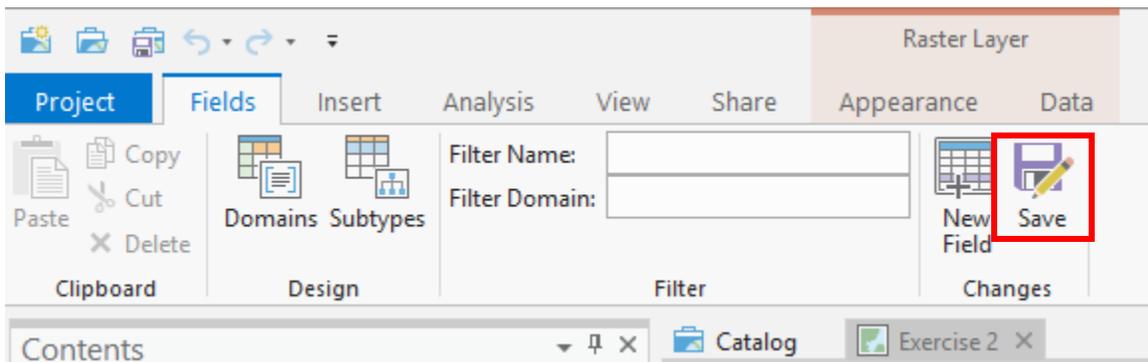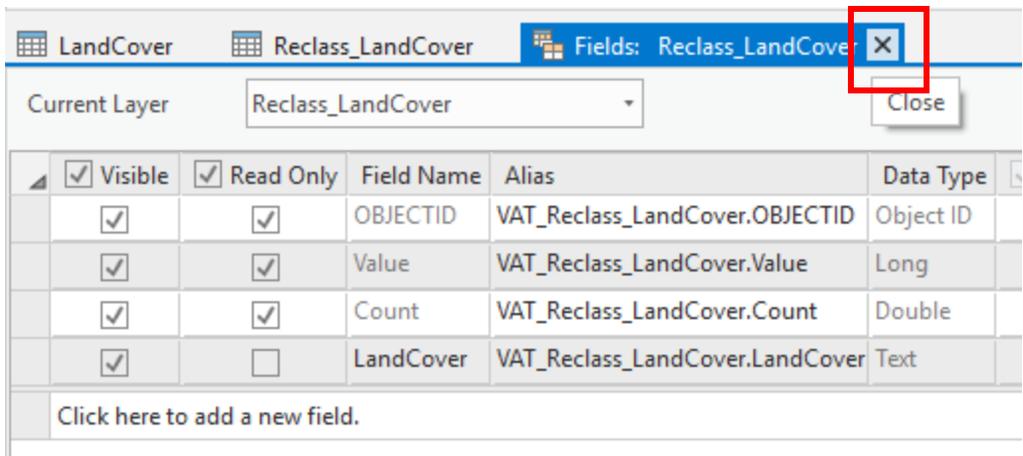
Notice that in the Reclass_LandCover table there is an empty field LandCover and that all field names have been preceded by their table name to disambiguate. The field is thus VAT_Reclass_LandCover.LandCover.
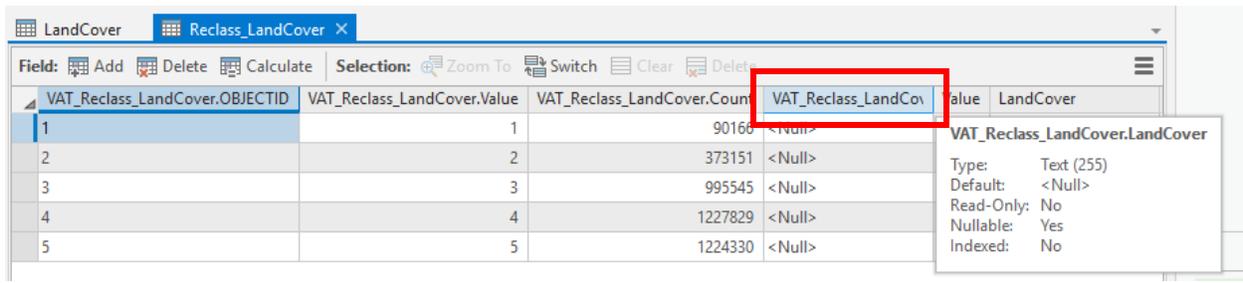
Right click on this Field and select Calculate Field
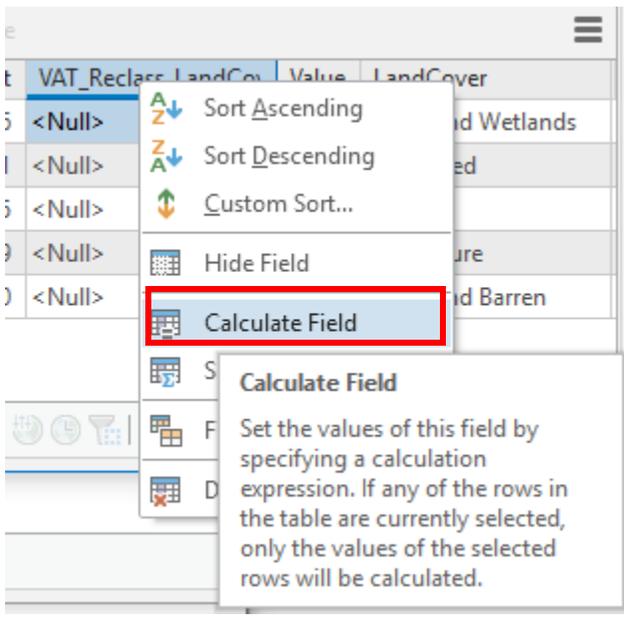
In the Geoprocessing pane the Calculate Field tool opens. Double click on LCReclass.csv.LandCover in Fields so that it appears in the box below =. Then click Run.
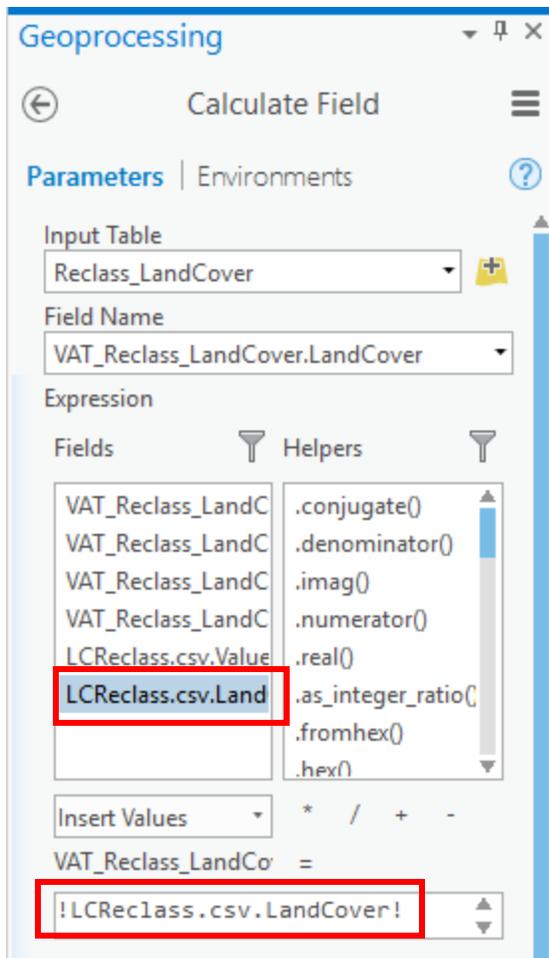
The result should be that the LandCover values are written to the empty field.

Under Table Options select Joins and Relates, Remove all Joins.
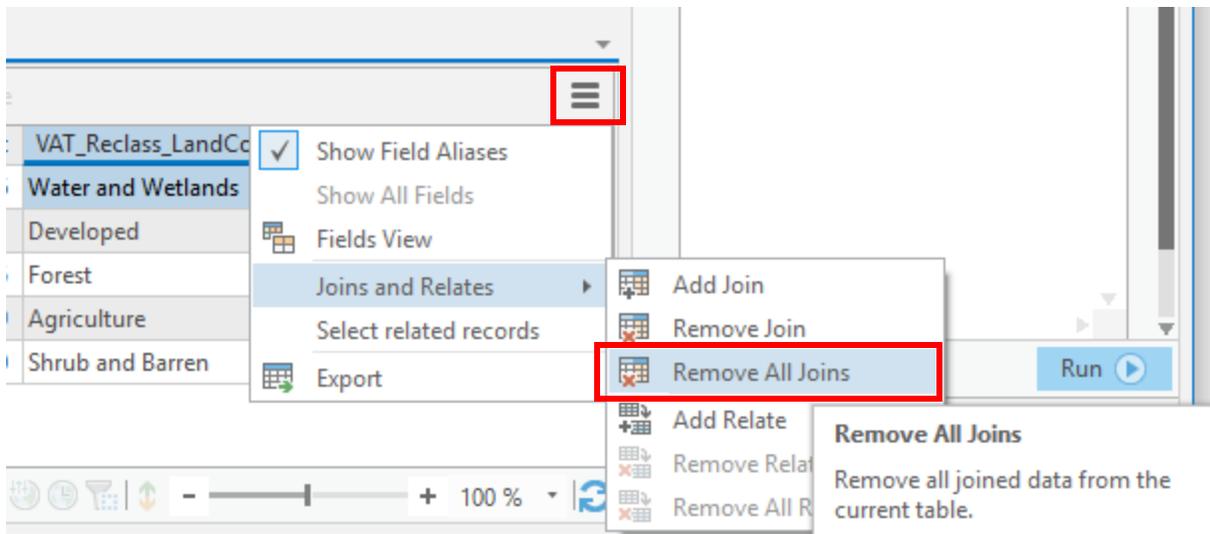
Close and Reopen the table and you should now see that without joins the simplified LandCover definitions are part of the table.

Remove and re-add the Reclass_LandCover raster to the map to get a table of contents entry that gives the text LandCover definitions
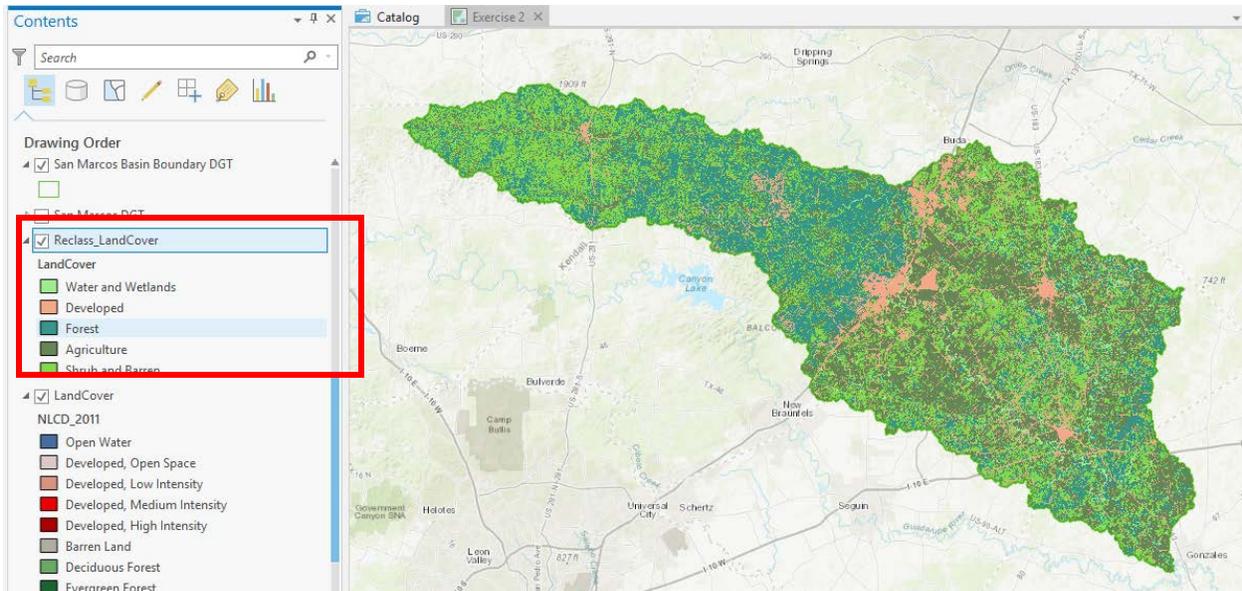
Save your project.

To Turn in:

5. *Prepare a map layout showing the San Marcos Subbasin land cover aggregated into the five classes. Include a scale bar, north arrow, title and legend so that this map may be unambiguously interpreted. Prepare a table giving the area and area percentage of each aggregated land cover in the subbasin. Report also the total area and reconcile any differences in total area with subbasin area values reported above.*

Where is My Stuff?

You now have all the content for a basemap for the San Marcos watershed. However some of it is online and some of it on your desktop. Let's tidy up the project removing unnecessary layers and noting where the data for each layer is stored.

For each layer in your Map Project table of contents right click and select Properties
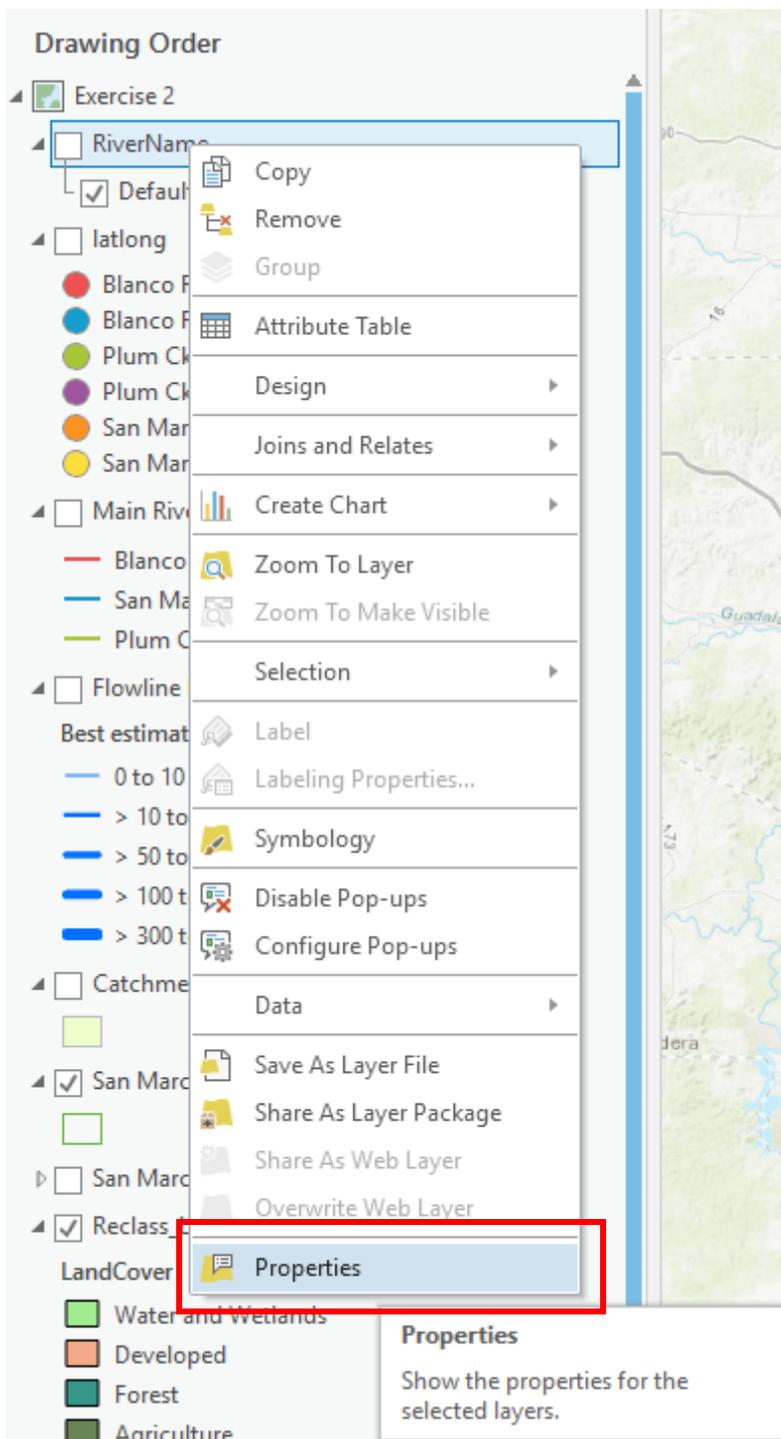
In the Layer Properties window click on Source and note the Location of the Data. For example for the RiverName layer, the layer of labels with River Names we see that this is in the Desktop database, even though it was created online.
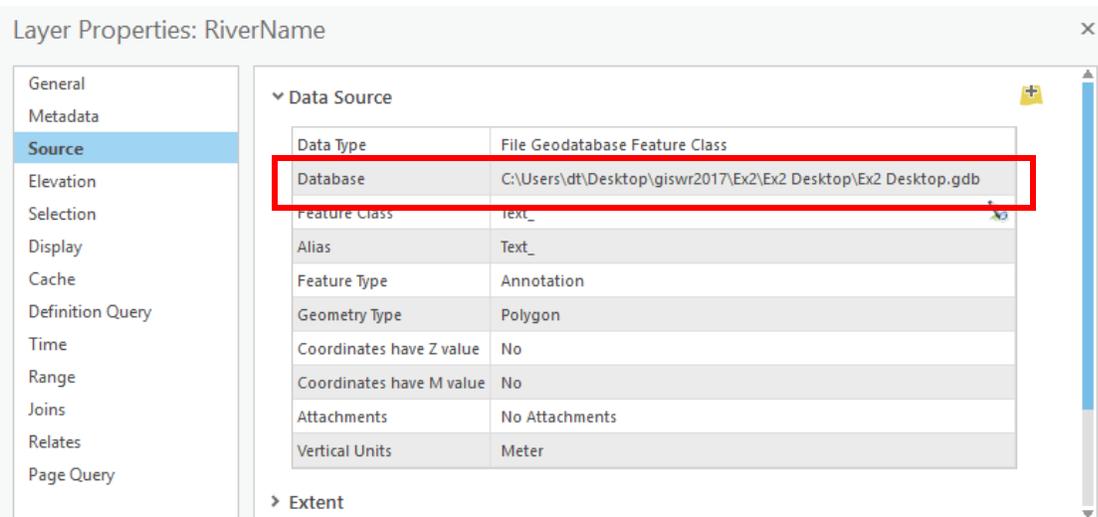
On the other hand the Main River Reaches layer is hosted online at services1.arcgis.com
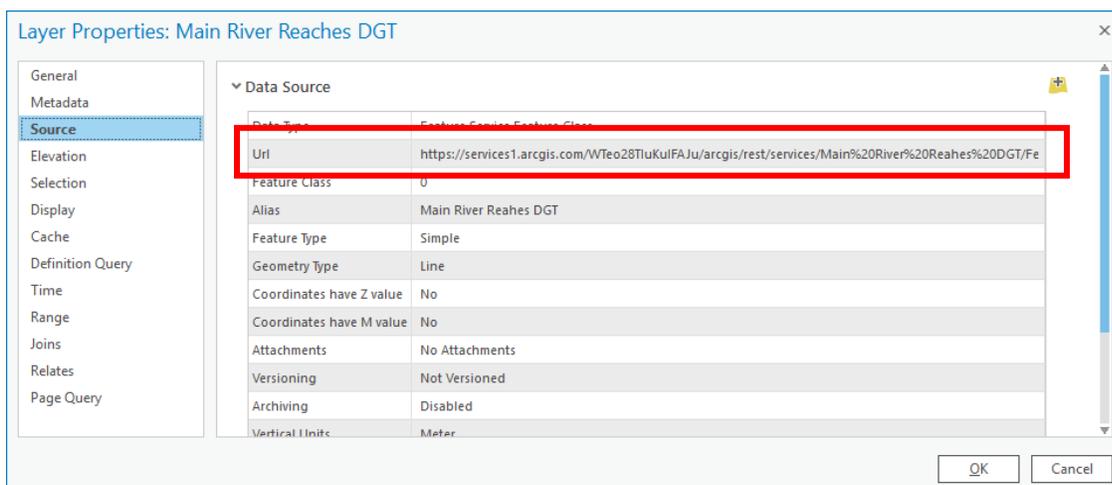
Check each layer in your map. Retain the following layers (your names may be slightly different), removing all others. Fill out the table indicating where it is stored

Layer	Storage Location
RiverName	Desktop database
latlong	
Main River Reaches	Online web service
Flowline	
Catchments	
San Marcos Basin Boundary	
San Marcos	
Reclass_LandCover	
World Topo Map	

Note that the land cover raster for the whole of Texas and extracted landcover before simplification were removed to cut down on space.

Once you have removed layers not in the list above, save your project.

To Turn in:

6. *The table above reporting the location of each layer in your San Marcos Subbasin basemap.*

Summary of items to be turned in

1. *A screen shot of your web map showing the San Marcos Subbasin with HUC 10 and HUC 12 watersheds and subwatersheds. Report the following data associated with the San Marcos Subbasin*
   - *Area of San Marcos Subbasin in mi^2*
   - *Number of HUC 12 subwatersheds in San Marcos Subbasin*
   - *Average area of HUC 12 subwatersheds in San Marcos Subbasin in mi^2*
   - *Number of HUC 10 watersheds in San Marcos Subbasin*
   - *Average area of HUC 10 watersheds in San Marcos Subbasin in mi^2*

2. *A screenshot of your web map showing Flowlines symbolized with mean flow, Catchments and San Marcos Basin Boundary. Show legend information for the Flowlines. Report the following data associated with the San Marcos Subbasin Flowlines and Catchments*
   - *Total Area of San Marcos Subbasin determined from summing Catchment areas as well as from the most downstream flowline in mi^2. Comment on any differences and any differences with the area reported in #1 above.*
   - *Number of NHDPlus Catchments in San Marcos Subbasin*
   - *Average area of NHDPlus Catchments in San Marcos Subbasin in mi^2*
   - *Number of NHDPlus flowlines in San Marcos Subbasin*
   - *Average length of NHDPlus flowlines in San Marcos Subbasin in mi*
   - *Total length of NHDPlus flowlines in San Marcos Subbasin in mi*
   - *Best estimate of actual mean flow at the outlet of the San Marcos Subbasin in cfs.*
   - *Common Identifier (COMID) of the Flowline at the outlet of the San Marcos Subbasin*

3. *A screen shot of your web map showing the three main rivers with labels in the San Marcos Subbasin*

4. *A screen shot of your web map showing the labeled stream gauges and the table above with quantities filled in and interpretive comments on differences.*

5. *Prepare a map layout showing the San Marcos Subbasin land cover aggregated into the five classes. Include a scale bar, north arrow, title and legend so that this map may be unambiguously interpreted. Prepare a table giving the area and area percentage of each aggregated land cover in the subbasin. Report also the total area and reconcile any differences in total area with subbasin area values reported above.*

6. *The table above reporting the location of each layer in your San Marcos Subbasin basemap.*