Exercise 2

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

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Summary of items to be turned in

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: <u>http://arcg.is/1JW0DBm</u> 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

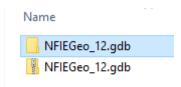
And scroll down to Content

This resource is shared under the Creative Commons Attribution CC BY. http://creativecommons.org/licenses/by/4.0/	
Content	
data/contents/NFIEGeo_12.gdb.zip 127.1 MB	۲

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/

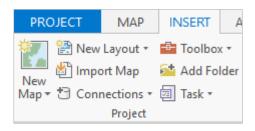
Unzip this file and navigate down through the folders to a zipped geodatabase file, and unzip that. Move the geodatabase file to your working directory for this exercise.



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.

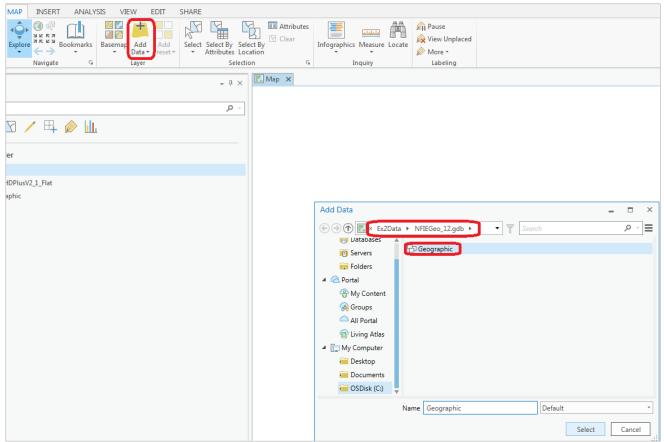
Create a New Project						
Name	Exercise2					
Location	C:\GISWR2016\Ex2	<u></u>				
	Create a new folder for this project					
		OK Cancel				

Insert a New Map into your view

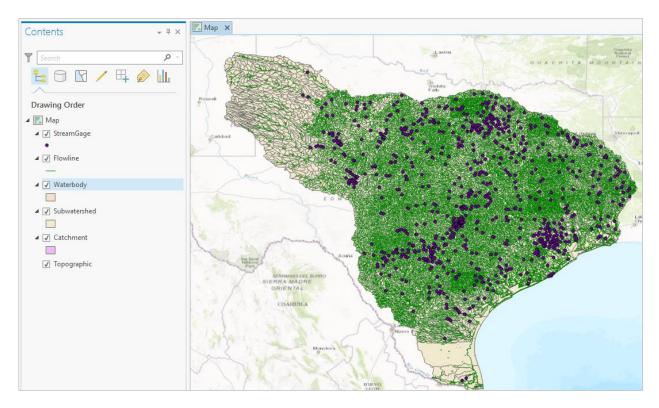


And you'll see a big topographic map of the United States show up.

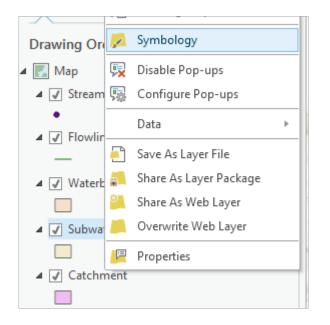
Add the **NFIEGeo_12** data to the map by using the **Add Data** button and navigating to the Feature Dataset **Geographic** data.



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**

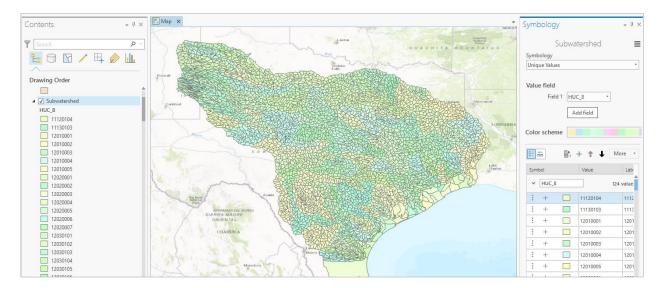
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Single Symbol Draw using single symbol	
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Unique Values Draw categories using unique values of one or multiple fields.	
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And select **HUC_8** as the Field to be used to display these values

Symbology	⊸ ₽ :
Subwatershed	≡
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Value field	
Add field	
Color scheme	

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.

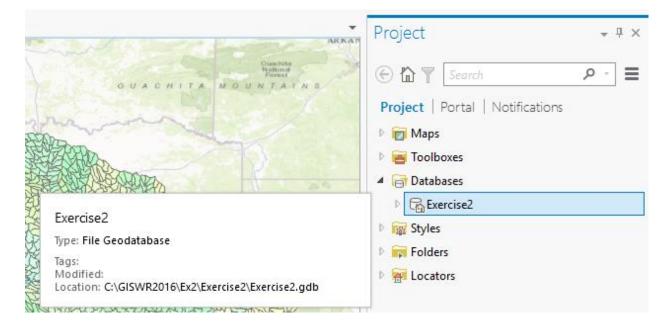


Use **Project/Save** to save the current version of your project so you don't have to recreate this map display again. The project is saved in a file **Exercise2.aprx**, in the folder **Exercise2**.

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

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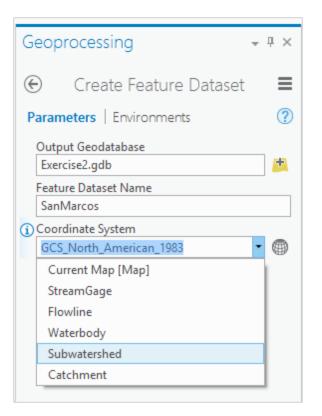
If you open up the Databases section of the display, you'll see a new Geodatabase already created for you called **Exercise2**, consistent with the name of the Project that we created when opening ArcGIS Pro.



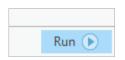
Right click on this Exercise2 Geodatabase and create a new Feature Dataset.

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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.

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SanMarcos Type: File Geodatabase Feature Dataset Tags: Modified: Location: C:\GISWR2016\Ex2\Exercise2\Exercise2.gdb \SanMarcos	Eccators
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Selecting the Watersheds in the San Marcos Basin

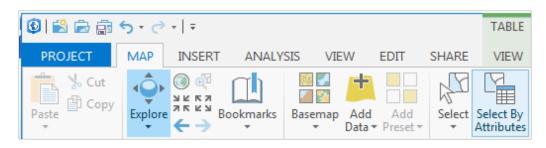
Let's zoom into the San Marcos basin.

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**

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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
	1								

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

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	Click Add Clause to begin building your query or click SQL to write your expression directly.				
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And in the resulting display choose **HUC_8 is Equal to 12100203** using the choices in the boxes available.

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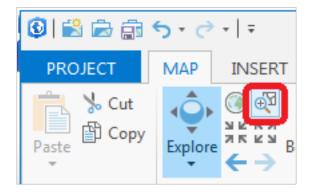
Once your clause is input, hit the Add button so that your expression is specified completely

Geoprocessing - # ×
Select Layer By Attribute
Parameters Environments (?)
Layer Name or Table View Subwatershed
Selection type New selection
Expression
HUC_8 is Equal to 12100203
Add Clause 📏 🗸 🚘 🔚
Invert Where Clause

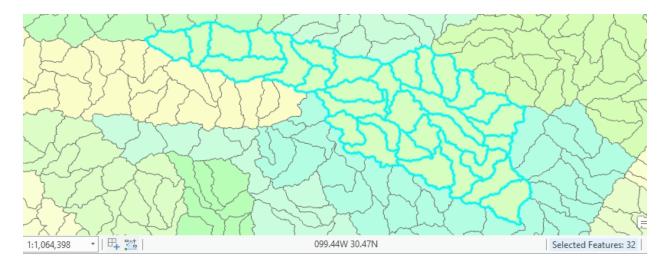
and then hit **Run** at the bottom of the **Geoprocessing** pane to select the San Marcos basin by its HUC_8 identifier. You'll see that this selects 32 of the HUC-12 Subwatersheds that lie within the San Marcos basin (one HUC-8 Subbasin). If you hit the **Selected** button at the bottom of the Table,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

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170	Polygon		12100203	1210020304	121002030406	36726	0		1347268	
184	Polygon		12100203	1210020305	121002030503	32568	0		1342251	
188	Polygon		12100203	1210020304	121002030410	22111	0		1341269	
192	Polygon	123663	12100203	1210020304	121002030408	11095	0		1333334	
338	Polygon	226560	12100203	1210020304	121002030405	23122	0		1375388	
364	Polygon	123640	12100203	1210020305	121002030501	36224	0		1331427	
366	Polygon	123716	12100203	1210020303	121002030307	17548	0		1376892	
367	Polygon	123717	12100203	1210020305	121002030502	31303	0		1376054	Run 🕞
373	Polygon		12100203	1210020303	121002030306	34527	0		1376892	Select Layer By Attribute Completed successfully
32 of 41	59 selected	d							+ 100 % *	Proj Sym Lab Chart Ele Job Geo

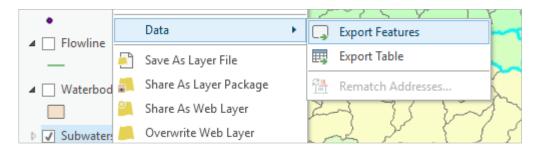
To zoom to this selection, use the **Zoom to Selected Features** button in the map tab.



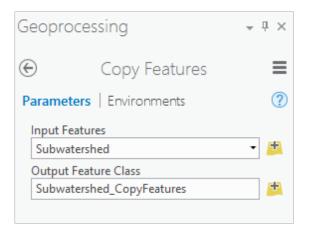
And you'll see a close up view of the San Marcos Subwatersheds.



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**.

Output Feature Class	-	
(ⓒ ○) ⑦ [] « Exercise2.gdb ▶ SanMarcos ▼ Search		€ ۲
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Save]	Cancel

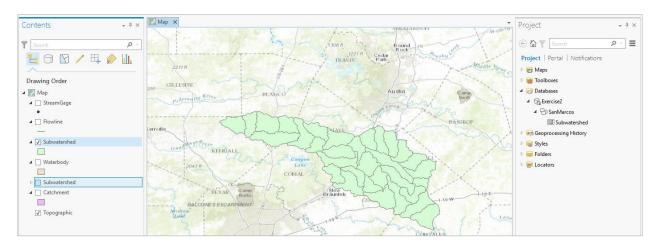
Click **Run** at the bottom of the Geoprocessing pane.

Geoprocessing	≁ ų ×
€ Copy Features	≡
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Clear the previous HUC_8 selection with the **Clear** button.

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E	د Explore		Bookmarks	Basemap		Add Preset •		Select By Attributes			Infographics	Measure Locate	 Image: Pause Image: Wiew Unplaced Image: Image: Image: Pause Image: P
		Navigate	La La		Layer			Se	lection	La Ca	I	nquiry	Labeling

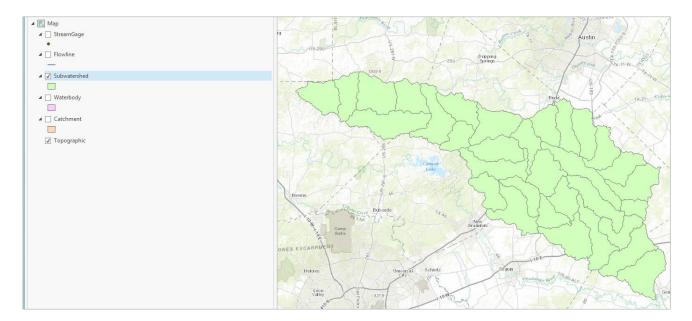
In the **Project** pane, you can navigate to the San Marcos feature dataset and you'll see there is now a Subwatershed feature class located there, and that it has been added to the Map view. Turn off the lower Subwatersheds for all of the HUC2 region, and you'll see just the Subwatersheds of the San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



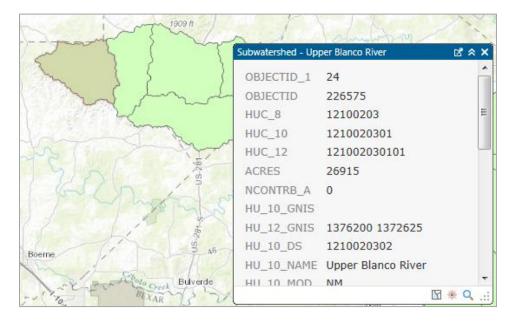
Remove the larger Subwatershed feature class for all of the Region 12 by right clicking on it and selecting **Remove**



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.

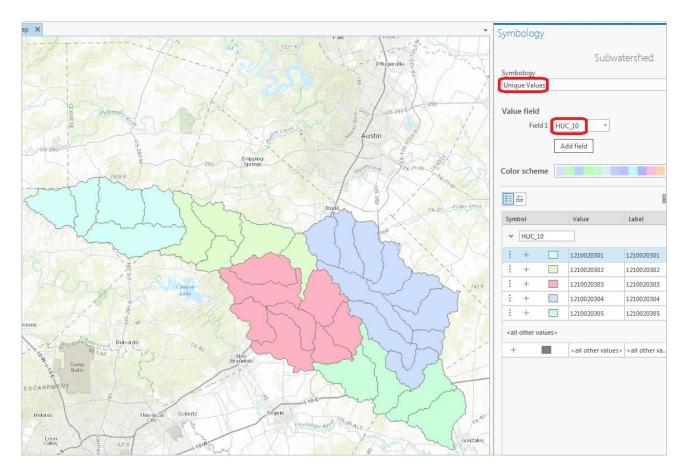


Click on the North-Western subwatershed on the map.



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.

Layer Properties: Subv	vatershed		>
General	✓ Data Source		æ Í
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Source	Data Type	File Geodatabase Feature Class	
Elevation	Database	C:\GISWR2016\Ex2\Exercise2\Exercise2.gdb	
Selection	Feature Class	Subwatershed	2
Display	Alias	Subwatershed	
Cache	Feature Dataset	SanMarcos	
Definition Query	Feature Type	Simple	
Time	Geometry Type	Polygon	
Range	Coordinates have Z value	No	
Indexes	Coordinates have M value	No	
Joins	Attachments	No Attachments	
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		ОК	Cancel

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.

🗸 🌄 Ex2 🔥	Name	Date modified	Туре	Size
Exercise2	Exercise2.gdb	9/7/2016 8:34 PM	File folder	
Exercise2.gdb	🛃 ImportLog	9/7/2016 8:33 PM	File folder	
🛃 ImportLog	on Index	9/7/2016 8:36 PM	File folder	
> 🌄 Index	👼 Exercise2.aprx	9/7/2016 8:25 PM	ArcGIS Project File	42 KB
NFIEGeo_12.gdb	Exercise2.tbx	9/7/2016 7:49 PM	ArcGIS Toolbox	4 KB

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).

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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.

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Basin		+
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Unsplit lines		

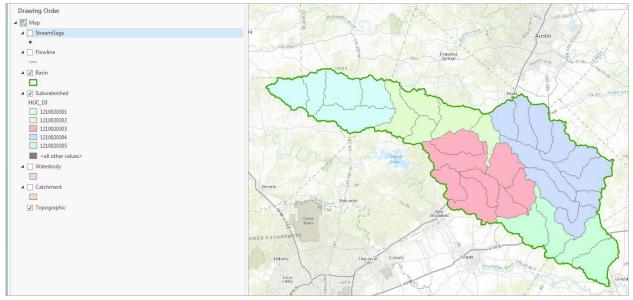
And you'll see a new Basin feature class pop up on your map display



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**.

Symbology		≁ Ū ×
e	Format Polygon Symbol	≡
Gallery Properties		
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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.

	Basin 🗙					
Fi	eld: 賱 New	🕎 Dele	ete 📳 Calcula	te Selection:	🕀 Zoom To	5
	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.

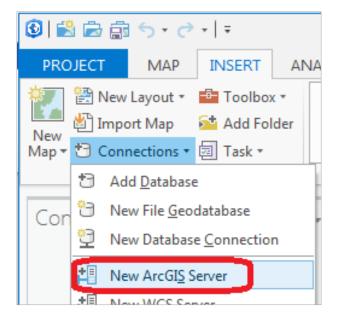


To be turned in: Make a map of the San Marcos basin with its HUC10 and HUC12 watersheds and subwatersheds. How many HUC10 and HUC12 units exist in the San Marcos Basin? Note that maps that you turn in should be clearly labeled so that they may be unambiguously interpreted with a title, scale, north arrow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

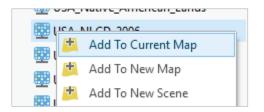
Add ArcGIS Se	erver User Connection	×
Server URL:	http://landscape2.arcgis.com/arcgis/	
	Example: http://gisserver.example.com:6080/arcgis/service	es
Optional: provid	e a username and password	
User Name:		
Password:		
	✓ Save Username / Password	
	OK Cance	:

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.

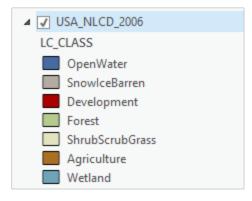
Navigate to **USA_NLCD_2006** in the **Project** pane under the **Servers** folder. This is the USGS Land Cover raster map of the United States.

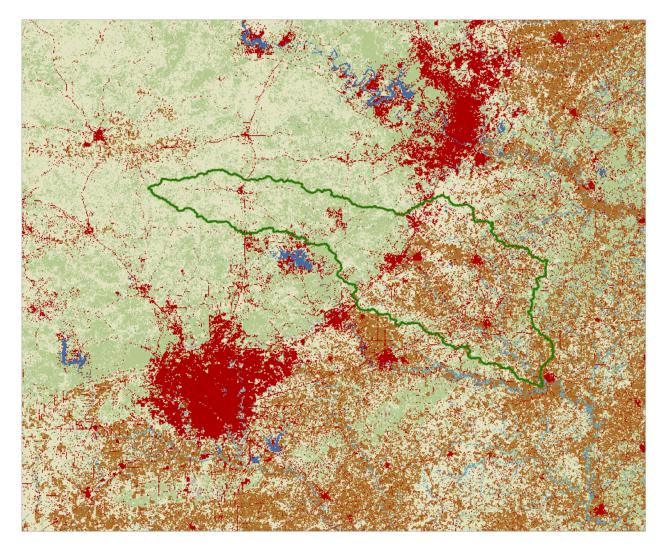
Servers	
arcgis on landscape2.ar	cgis.com (user) (2)
📴 USA_All_Federal_Lan	ds
USA_BLM_Lands	
📴 USA_Coal_Bed_Meth	ane_Basins
🔢 USA_Critical_Habitat	:
🔢 USA_Critical_Habitat	Final_2014
🔢 USA_Critical_Habitat	Proposed_2014
🔢 USA_Evapotranspirat	tion
USA_Flood_Risk	
USA_Historic_Sites	
USA_Land_Surface_F	orms
USA Native America	an_Lands
USA_NLCD_2006	

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**

Geoprocess	≁ î ×	
e	Dissolve	Ξ
Parameters	Open Another Tool	
Falameters	Dissolve X	
Input Feature Subwatershe	Clear Progress	

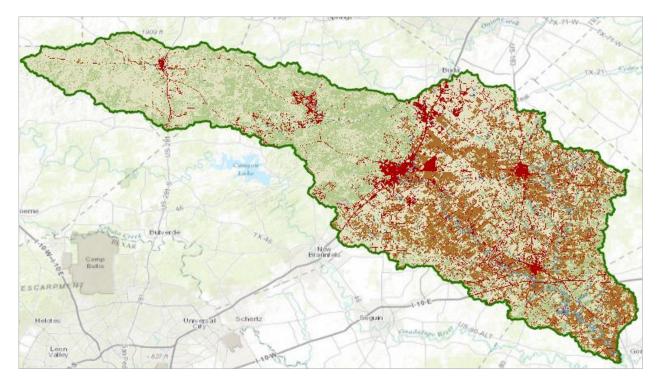
And search for Extract by Mask from the Spatial Analyst Tools

Geoprocessing - 4 ×	
€ Extract by mask × • ■	
Search Results (23) Extract by Mask (Spatial Analyst Tools)	
 Extract by Mask (Spatial Analyst Tools) Extracts the cells of a raster that correspond to to 	the areas defined by a mask.
Extract by Circle (Spatial Analyst Tools)	h

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.

Geoprocessing	+ 4 ×	
€ Extract by Mask	≡	
Parameters Environments	?	
Input raster USA_NLCD_2006	• 🖻	
Input raster or feature mask data Basin	-	
Output raster LandCover	(Output raster _WR\Ex2\Exercise2.kercise2.gdb\LandCover

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.

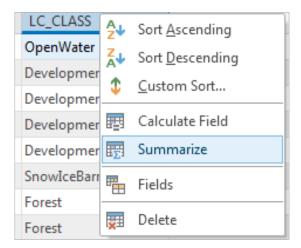
If you right click on the LandCover raster and open its **Properties**, and then select **Raster Information**, you'll see it is a raster with 30m x 30m cells (these are derived from 30m Landsat imagery).

ieneral	Vertical Units Meter		
/letadata	✓ Raster Information		
ource	Columns	4750	
levation			
ache	Rows	2927	
ins	Number of Bands	1	
lates	Cell Size X	30	
	Cell Size Y	30	
	Uncompressed Size	13.26 MB	
	Format	FGDBR	
	Source Type	Generic	
	Pixel Type	signed integer	
	Pixel Depth	8 Bit	
	NoData Value		

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.

III LandCover ×								
Field: 📰 New	Field: 📰 New 🕎 Delete 📰 Calculate					Zoom To	Swit	ch 🔄 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.

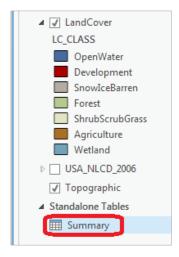


In the **Field** section select **Count** with a Statistic Type **SUM**, then save the result as a table called **Summary** in the **Exercise2** geodatabase (not in the SanMarcos feature dataset).

Geopro	cessing		₩ Ū ×
	Summ	ary Statistics	≡
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Input Tal LandCo Output T	ver		• 🛡
Summa	ry		<u>+</u>
Field 🕑	Tield(3)	Statistic Type	
Cou	int	▼ SUM	•
		•	•
Case field	4 🕗		
LC_	CLASS		•
			-

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.



	LandCover	📰 Summary 🗙			
Field: 📰 New 🕎 Delete 📰 Calculate Selection: 🕂 Zoom T					
⊿	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:

4	6	Databases
	4	🗟 Exercise2
		SanMarcos
		🖾 Basin
		🖾 Subwatershed
		LandCover
		E Summary

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

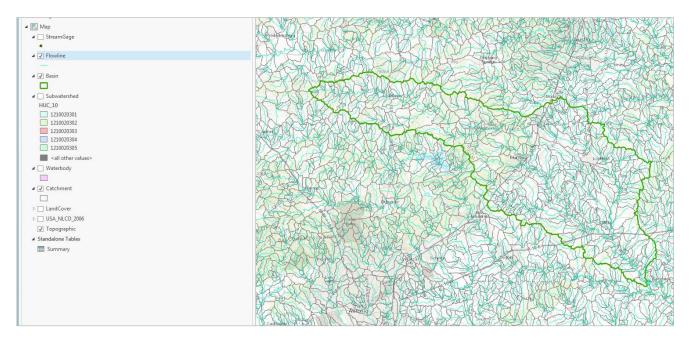
The count of the number of grid cells in this table, can be used with cell size to determine the area in each land cover class.

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.

Add Data	
€ → ♠ 💽 « NFIEGeo	_12.gdb 🕨 Geographic 🔹 🍸 So
💿 Living Atlas 🛛 🔺	
My Computer	Catchment Flowline
冠 Desktop	StreamGage
🔁 Documents	Subwatershed
冠 OSDisk (C:)	🖾 Waterbody
🔚 \\engr-disk\ENGR\C	

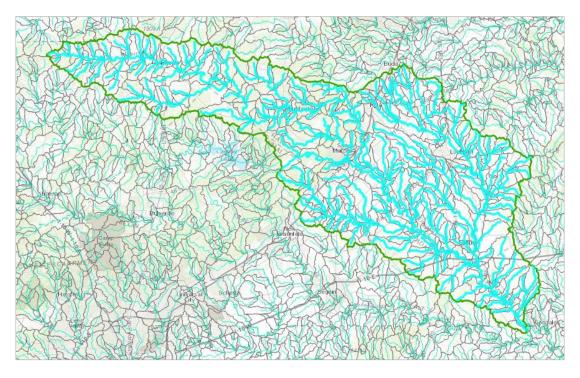


Now, let's select the features from our large dataset that lie within our Basin. Click the **Selection by Location** button on the *Map* tab.

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Paste	Explore	()) ⊕∑ УККИ УККИ УККИ УККИ УККИ	Bookmarks	Basemap	Add Data •	Add Preset •		Select By Attributes	Select By		Infog
Clipboard		Navigate	T _M		Layer			Se	lection	Es.	

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.

Geoprocessing	₩ ₽ ×
€ Select Layer By Location	≡
Parameters Environments	?
Input Feature Layer Flowline Relationship	•
Have their center in Selecting Features	
Basin Search Distance	- 💾
Decimal Degrees	•
Selection type	
New selection	•
Invert spatial relationship	

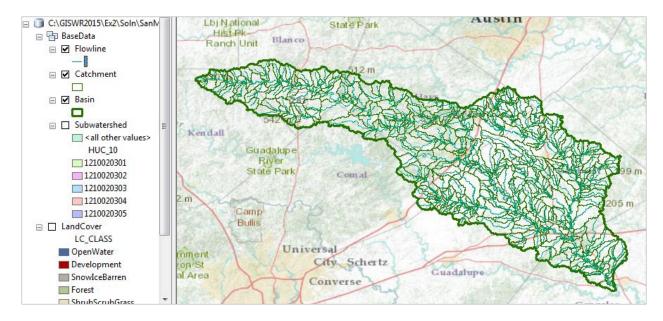


Export these selected Flowlines to a feature class called **Flowline** in the SanMarcos geodatabase, and add it to your Map display.

▲ 🖌 Flowline					
-	Ē	Сору			
🔺 🖌 Basin	Ē	Remove			
		Group			
Subwatersh	ned	Attribute Table			
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12100203		Joins and Relates	Þ		
12100203	1.1.1	Create Chart	Þ		
12100203		Zoom To Layer			
<all othe<="" p=""></all>	a la cal	Zoom To Make Visible			
		Selection	×		
▲ 🛃 Catchment	: 🔬	Label			
	<u>e</u>	Labeling Properties			
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USA_NLCD J Topograph	(iii)	Disable Pop-ups			
✓ Topograph ▲ Standalone Tal	IIC III				
📰 Summary		Data	•	📮 Export Featur	es
	-	Save As Layer File		拱 Export Table	
TTTTTT	Geopro	cessing		₩ 1	L ×
X TO	_				
(Add)	€	Copy Fea	ture	S	
	Paramete	ers Environments			?
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N X NU		roject\SanMarcos.gdk	o\Base	Data\Flowline	œ.
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Remove the original Flowline feature class for Region 12 from your map display.

C:\pjruess\giswr2016\Ex2\Ex2_project\SanMarcos.gdb\BaseData\Flowline



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.

Symbo	logy	- ₽ ×
	Flowline	≡
Symbolog	ду	
Single Sy	rmbol	-
Symbol	ize your layer using one symbo	ol
##	Single Symbol Draw using single symbol	
Symbol	ize your layer via categories	
+++	Unique Values Draw categories using unique value	es of one o
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Ħ	Graduated Symbols Draw quantities using graduated sy	/mbols.

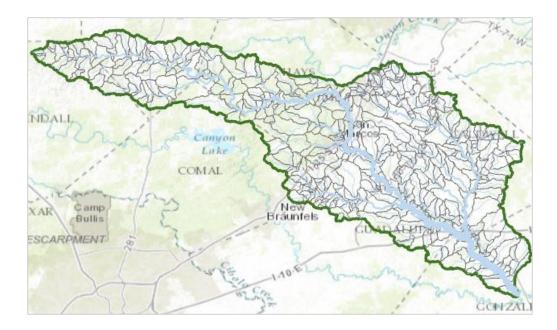
Symbology		*	ųΧ
	Flowline		≡
Symbology			
Graduated Symbols 🔹			
Field	Q0001C	•	
Normalization	<none></none>	•	
Method	Natural Breaks (Jenks)	•	
Classes	5	•	
Graduated Symbol			
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Template	_		

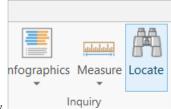
Click Apply.

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



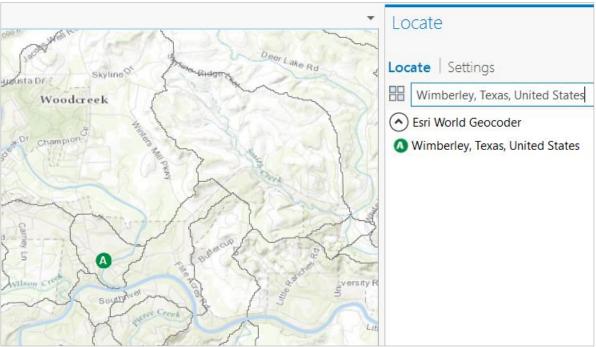
Repeat the same process with **Catchment** as you did for **Flowline:** (1) Use Select by Location to select those catchments having their center in the San Marcos basin; (2) Export those catchments to the San Marcos feature dataset as a new feature class; (3) Remove the larger Region 12 catchment set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



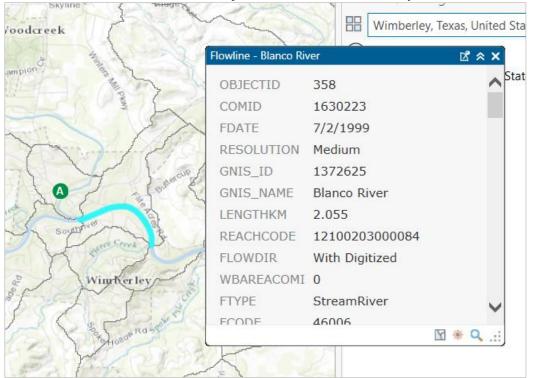


to locate the town of Wimberley,

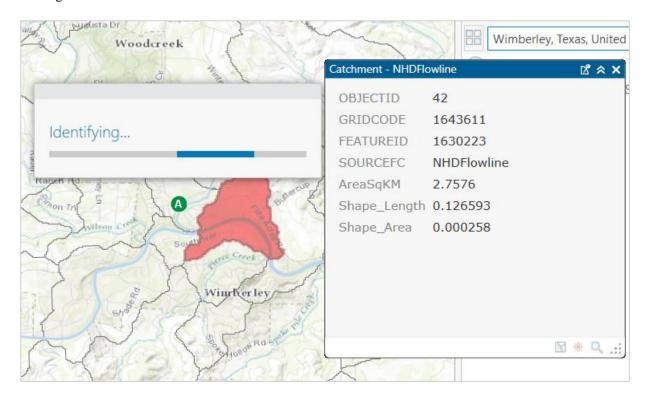
Use the Locate button in the Map view Texas



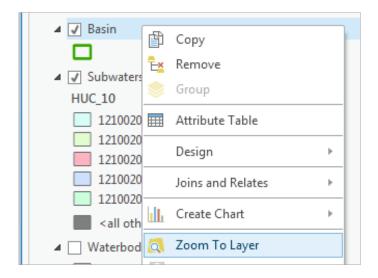
Click on the reach of the Blanco River just downstream of Wimberley:



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.



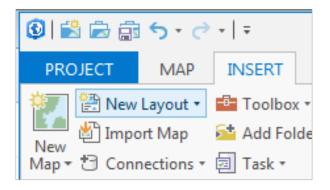
Use **Zoom to Layer** for the **Basin** feature class to get back the original extent of our map.



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.

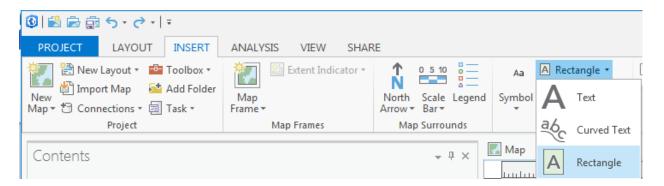
Now let's create a map and do some summarization of watershed attributes. We'll need to create a new Layout with the **New Layout** button in the *Insert* tab.



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

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PROJECT LAYOUT INSERT	ANALYSIS VIEW SHA
Import Map Import Map New Import Map Map ▼ Connections ▼ Project	
Contents	Map
Search	Default Map (1:896,

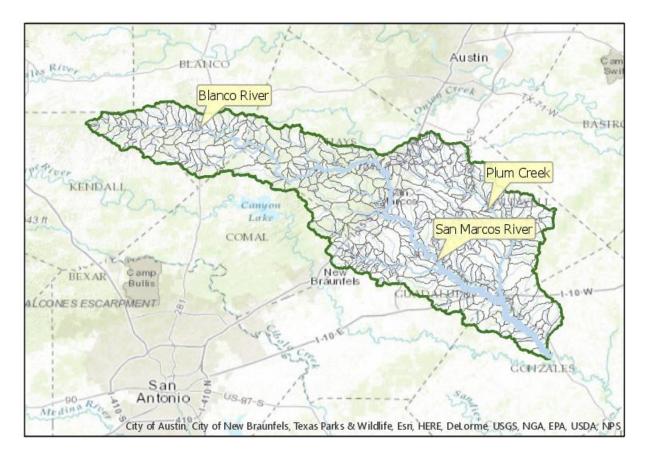
add a Text Rectangle,



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**.

🖌 🖻 🗛 Text 2			
🗸 륩 🗛 Text 1			
🗸 🔓 🔺 Text			
🛛 🗸 🔐 🔣 Map Map		Zoom to Page	
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	+	<u>A</u> lign	F
	122	Save to Style	
	د	Navigate	
	12°	Select	
	ρ	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.

		Data	Export Feat			eatures	(1999	Medium
o	<u>-</u>	Save As Layer File		E	Export Ta	able	(1999	Medium
5		Share As Layer Package		1	Remate	Export Table	11000	KA P
n) eli	÷	Share As Web Layer	l		Polyl	Export current table	to nev	v table.

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

Geoproc	≁ ū ×	
\odot	Copy Rows	≡
Paramete	rs Environments	?
Input Rov Flowline		• 💾
(i) Output T box\Aca	able idemics\GIS_in_WI_\Ex2\Flow	line.csv 🖶
D:\Dropb	ox\Academics\GIS_in_WR\Ex	2\Flowline.csv

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 <u>http://waterdata.usgs.gov/tx/nwis/si</u>

SiteID SiteName

Latitude Longitude DASqMile MAFlow

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

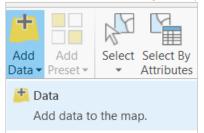
Decimal Degrees (DD) = Degrees +
$$\frac{Min}{60} + \frac{Seconds}{3600}$$

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	29° 59' 39"	98° 05' 19"	29	59	39	98	5	19	29.9942	-98.0886	355	142
08171300	Blanco Rv nr Kyle, Tx	29° 58' 45"	97° 54' 35"	29	58	45	97	54	35	29.9792	-97.9097	412	165
08172400	Plum Ck at Lockhart, Tx	29° 55' 22"	97° 40' 44"	29	55	22	97	40	44	29.9228	-97.6789	112	49
08173000	Plum Ck nr Luling, Tx	29° 41' 58"	97º 36' 12"	29	41	58	97	36	12	29.6994	-97.6033	309	114
08172000	San Marcos Rv at Luling, Tx	29° 39' 58"	97° 39' 02"	29	39	58	97	39	2	29.6661	-97.6506	838	408
08170500	San Marcos Rv at San Marcos, Tx	29° 53' 20"	97° 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.



t ► Folders ► Ex2 ► •
Data
🚞 Exercise2
🖬 latlong.xlsx
latlong.csv

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.

eld: 📰 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	40
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	17

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

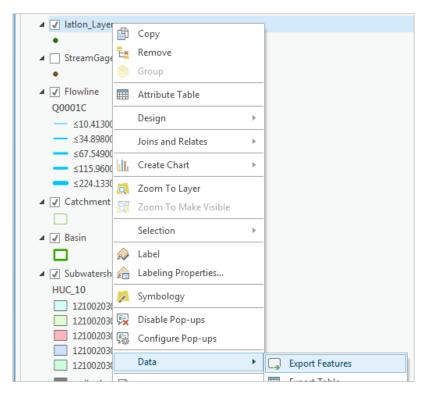
		Forest		Joins and Relates
	ShrubS		х _Y	Display XY Data
		Agricul Wetlan		Geocode Addresses
	✓ Topograp Standalone		•	Disable Pop-ups
4			鸁	Configure Pop-ups
		Summar	P	Properties
		latlong.c	sv	

(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.

Geoprocessing
Make XY Event Layer
Parameters Environments
XY Table
latlong.csv
X Field
LongDD
Y Field
LatDD
Z Field
Layer Name
latlong_Layer
i) Spatial Reference
GCS_North_American_1983
Current Map [Map]

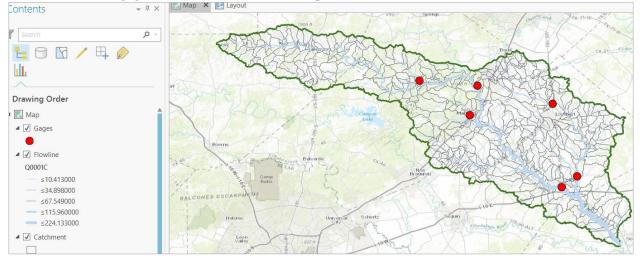
Hit **Run** to create the and voila! Your gage points show up on the map right along the San Marcos River just like they should. Magic! I remember the first time I did this I was really thrilled. This stuff really works. I can create data points myself! If you don't see any points, don't be dismayed. 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.

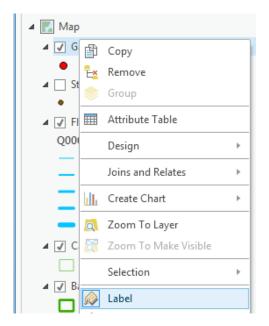


Geoprocessing -						
Copy Features	≡					
Parameters Environments	?					
Input Features						
latlon_Layer	- 🖻					
Output Feature Class						
Gages	#					

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



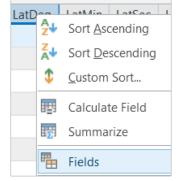
Now let's label the Gages with their Names. Right click on the **Gage** feature class and click on **Label Features**. You'll see some labels show up in small lettering. Check your previous layout to make sure that all labels and text boxes show up correctly. If a text box is blocking a gage label, drag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

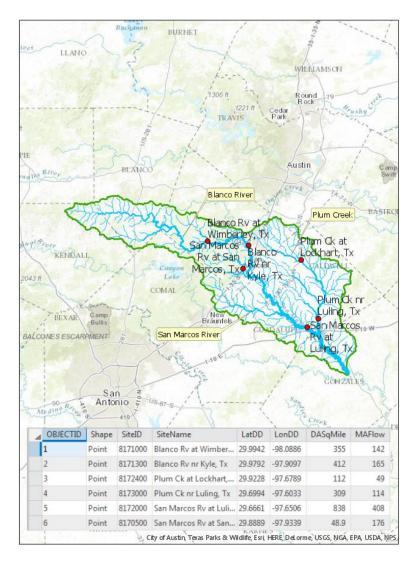


	III Gages Fields: Gages 🗙												
Cu	Current Layer Gages												
⊿	Visible	Read Only	Field Name	Alias	Data Type	Allow NULL	Highlight	Number Format [
			LatDeg	LatDeg	Long	1		Numeric					
			LatMin	LatMin	Long	1		Numeric					
			LatSec	LatSec	Long	1		Numeric					
			LongDeg	LongDeg	Long	1		Numeric					
			LongMin	LongMin	Long	1		Numeric					
			LongSec	LongSec	Long	1		Numeric					
	1		LatDD	LatDD	Double	1		Numeric					
	1		LongDD	LongDD	Double	1		Numeric					
	1		DASqMile	DASqMile	Double	1		Numeric					
	1		MAFlow	MAFlow	Long	1		Numeric					

Save the changes to your table view:

	FEATURE LAYER							
APPE.	PPEARANCE LABELING DATA							
	New Field	Save						
	Cha	ndes						

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



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.

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Click Run.

Use the **Chrome** web viewer for the rest of this task. Open HydroShare at <u>http://www.hydroshare.org</u>. 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

Apps 🔺 Bookmarks					
HYDROSHARE	MY RESOURCES	DISCOVER	COLLABORATE	APPS	HELP
ck on Create New					
HYDROSHARE	MY RESOURCES	DISCOVE	R		
My Resour	ces				
+ Create new	*				

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

HYDROSHARE	MY RESOURCES	DISCOVER	COLLABORATE	APPS	HELP
Select a res	ource type	and up	load files a	as nee	eded to create a new resource

- Files you upload here will be grouped together into a "Resource" in HydroShare.
- File size is limited to 1 GB per file for direct browser upload from your local disk.
- Files larger than 1GB can be imported directly from any iRODS account. You can create a HydroShare iRODS account from your user profile page. See help with iRODS directly.
- You can also add files directly from any iRODS server regardless of the file size.

Select a resource type	Geographic Feature (ESF	RI Shapefiles)	1
Title	San Marcos Basin	2	

Add your files here:

Only the listed file types can be uploaded: [".zip", ".shp", ".shx", ".dbf", ".prj", ".sbx", ".sbn", ".cpg", ".xml", ".fbn", ".fbx", ".ain", ".aih", ".atx", ".ixs", ".mxs"]. Multiple file upload is allowed.

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	Choose Files	Nc	file chosen
		-	3

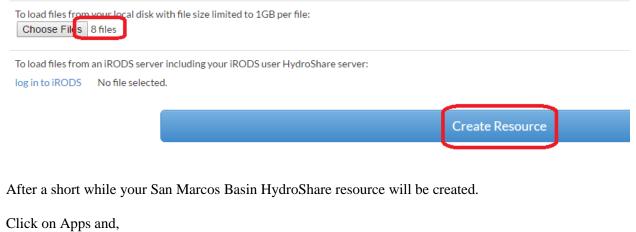
Click on Choose Files and browse to select the 8 shapefiles that comprise the San Marcos Basin shapefile that you just exported from ArcGIS Pro

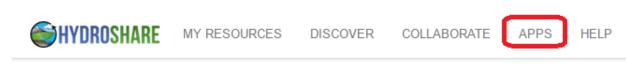
arcgis on landscape2.arcgis.com (user).ags	9/7/2016 8:49 PM	AGS File	4 KB
👼 Exercise2.aprx	9/7/2016 8:25 PM	ArcGIS Project File	42 KB
Exercise2.tbx	9/7/2016 7:49 PM	ArcGIS Toolbox	4 KB
SanMarcos.cpg	9/7/2016 11:21 PM	CPG File	1 KB
SanMarcos.dbf	9/7/2016 11:21 PM	DBF File	1 KB
📄 SanMarcos.prj	9/7/2016 11:21 PM	PRJ File	1 KB
SanMarcos.sbn	9/7/2016 11:21 PM	SBN File	1 KB
I SanMarcos.sbx	9/7/2016 11:21 PM	Adobe Illustrator	1 KB
SanMarcos.shp	9/7/2016 11:21 PM	SHP File	57 KB
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避 SanMarcos.shp.xml	9/7/2016 11:21 PM	XML Document	88 KB
SanMarcos.shx	9/7/2016 11:21 PM	SHX File	1 KB
- · ·		····	

Click Open. Then click Create Resource.

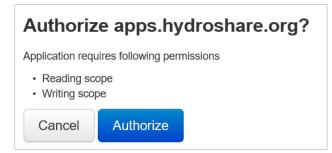
Add your files here:

Only the listed file types can be uploaded: [".zip", ".shp", ".shx", ".dbf", ".prj", ".sbx", ".sbn", ".cpg", ".xml", ".fbn", ".fbx", ".ain", ".aih", ".atx", ".ixs", ".mxs"]. Multiple file upload is allowed.





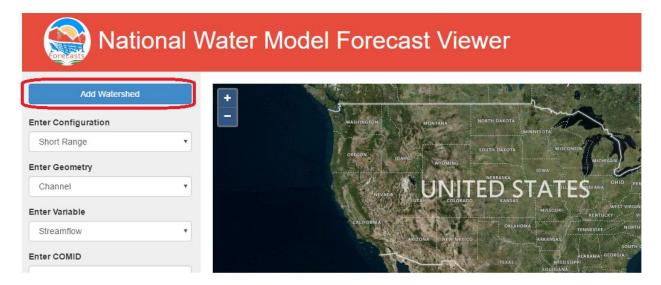
Authorize apps.hydroshare.org. Note that you are authorizing the app to access data that you have in HydroShare. This authorization will be used to access the San Marcos Basin resource you just created.



Select the National Water Model Forecast Viewer.



Click on Add Watershed



Click on San Marcos Basin and Add

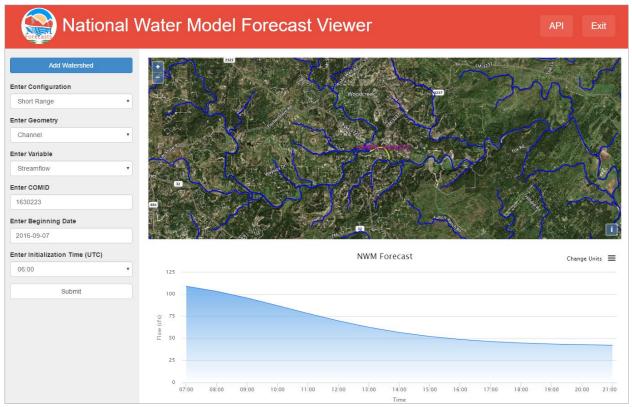
Add a watershed from HydroShare							
		Title		Owner]		
(۲	San Marcos Basin		David Tarboton	D		
					Close Add		

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

National Water Model Forecast 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

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This resultant excel file will look something like this:

	А	В
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)

Add Watershed		+	100	177	52	W.K.	1
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Enter Variable			m	KW.	1		
Streamflow	•	R	No BR	10 3	. Kill	NUF G	-6
Enter COMID		III	Monthalia	27	- N	s Cont	
1632017		County Ro	Provide State	15000	1 and		لر
Enter Beginning Date				1 10	and i	Summerfille	1
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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.