Exercise 2. Building a Base Dataset of the San Marcos Basin

GIS in Water Resources Fall 2015

Prepared by David R. Maidment and David G. Tarboton

- Goals of the Exercise
- Computer and Data Requirements
- <u>Procedure for the Assignment</u>
 - 1. <u>Getting started</u>
 - 2. Selecting the Watersheds in the San Marcos Basin
 - 3. Creating a San Marcos Basin Boundary
 - 4. Land cover information for the San Marcos Basin
 - 5. Obtaining the San Marcos Flowlines and Catchments
 - 6. Creating a Point Feature Class of Stream Gages
 - 7. Linear Referencing the Stream Gages
 - 8. Flow Data for the Blanco River
- 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 show how these locations can be connected to the NHDPlus flowlines using Linear Referencing and get some flow data for the Blanco River using the CUAHSI data downloader.

Computer and Data Requirements

To complete this exercise, you'll need to run ArcGIS 10.3 from a PC. You will download map packages of 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/	
data/contents/NFIEGeo_12.gdb.zip 127.1 MB	٩

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 geodatabase file.

Open ArcMap and use the Catalog tab in the top right hand corner to navigate to and open the NFIEGeo_12 geodatabase. If you don't see the Catalog tab in the top right corner of your ArcMap screen, use Windows/Catalog to open it within ArcMap.



You'll see that there are five feature classes in this **Geographic** feature dataset. Choose the **Subwatershed** feature class and add that to ArcMap. Using **Properties/Symbology**, recolor the Subwatersheds using the HUC_8 attribute.

Layers Subwatershed <all other="" values=""> HUC_8 11120104 11130103 12010001 12010002</all>	E Layer Properties					
12010003	General Source Select	ion Display Symbology	Fields Definition Query Labels	Joins & Relates Time	HTML Popup	場對
12010004	Show:	D		lung aut		
12010005	Features	Draw categories using	unique values or one field.	import		招將
12020001	Categories	Value Held	Color Ramp			
12020002	Unique values	HUC_8			-	明成
12020003	Match to symbols in a					2784A
12020004	Quantities	Symbol Value	Label	Count ^		25
12020005	Charts	I call other values	> <all other="" values=""></all>	0	Ster Co	-Section 1
12020006	Multiple Attributes	<heading></heading>	HUC 8	4159	E C L S	
12020007		11120104	11120104	1	199	
12030101		11130103	11130103	1		
12030102		12010001	12010001	33		
12030103	<	12010002	12010002	71		
12030104		12010003	12010003	17		
12030105	1 \ 1	12010004	12010004	57		
12030106		12010005	12010005	60		
12030107		12020001	12020001	46 👻		
12030108		Add All Values Add Val	lues Remove Remov	ve All Advanced	-	
12030109						

Let's create a new File Geodatabase in which we'll store the results of this exercise. Right click in a suitable folder area and create a new **File Geodatabase**:

	Folder		ð	Сору	
Ū	File Geodatabase		È	Paste	
	Personal Geodatabas	e	x	Delete	
	Database Connection	New File Geo	datab	ase	
	ArcGIS Server Conne	Create a new	file g	eodatabase.	
\diamond	Layer			New	•

We'll call this **SanMarcos.gdb** Within that, right click and create a new **Feature Dataset** that we'll call **BaseData**.



Ъ	Feature Dataset			New			
	Feature Class			Import	_		
	Table	able New Fea			1		
	View	Create	a new	/ feature dataset.	Service		
뮵	Relationship Class	_		Item Description	1		
	Raster Catalog			Properties			
-	_			rioperacian			

And call this **SanMarcos.**gdb. Within this, create a new **Feature Dataset**

and call it **BaseData**

New Feature Da	ataset		
Name:	BaseData		

choose a coordinate system from the existing information indexed under Layers (this is the Subwatershed feature class that is already open in the display window). This is a geographic coordinate system defined on the NAD83 datum, or North American Datum of 1983.

w Feature Dataset		X
Choose the coordinate system that will be u	sed for XY coordinates in this data.	
Geographic coordinate systems use latitude of the earth's surface. Projected coordinate transform latitude and longitude coordinate	and longitude coordinates on a spherical mod systems use a mathematical conversion to to a two-dimensional linear system.	lel
Type here to search	- @ 🔊 🚭 - 🔆	
ITRF 2008	•	
INSWC 9Z-2		
@ WGS 1966		
WGS 1972		
WGS 1972 TBE		
WGS 1984		
Projected Coordinate System Projected Coordinate System	-	
GCS_North_American_19	3	
Current coordinate system:		
GCS_North_American_1983	*	
WKID: 4269 Authority: EPSG		
Angular Unit: Degree (0.017453292519	433)	
Prime Meridian: Greenwich (0.0) Datum: D. North, American, 1983		
Spheroid: GRS_1980		
Semimajor Axis: 6378137.0		
Inverse Flattening: 298.257222101		
	*	
		_

Hit **Next**, and **Next** again to bypass having a Vertical Coordinate system, and then **Finish** to complete creating the Feature Dataset, leaving the tolerance information at the default values.

Ex2
🖃 🚞 Data
🗆 🗊 NFIEGeo_12.gdb
🗆 둼 Geographic
🖾 Catchment
😁 Flowline
😳 StreamGage
🖾 Subwatershed
🖾 Waterbody
🖃 🚞 Soln
🗆 🗊 SanMarcos.gdb
🔁 BaseData

This **BaseData** feature dataset within the **SanMarcos** geodatabase will hold the data that you create for the San Marcos Basin.

Selecting the Watersheds in the San Marcos Basin

Let's zoom into the San Marcos basin.

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

In ArcMap, open the Attribute Table of the Subwatershed feature class

Ta	ble								x
0	🛛 • 🔁 • 🏪 🏹	y 🖸 🖓 🕽	c .						
Su	bwatershed								×
Γ	OBJECTID_1 *	Shape *	OBJECTID	HUC_8	HUC_10	HUC_12	ACRES	NCONTRB	*
Þ	1	Polygon	212912	12110208	1211020806	121102080600	105412		
	2	Polygon	212913	12110208	1211020807	121102080700	83558		
	3	Polygon	212914	12110208	1211020808	121102080800	178671		
	4	Polygon	212915	12110208	1211020803	121102080300	289845		
	5	Polygon	212917	12110208	1211020810	121102081000	175787		
	6	Polygon	212918	12110208	1211020804	121102080400	229107		
	7	Polygon	212919	12110208	1211020805	121102080500	227239		
	8	Polygon	226615	12110208	1211020802	121102080200	177049		
	9	Polygon	226660	12110208	1211020809	121102080900	232263		
	10	Polygon	226661	12110208	1211020801	121102080100	109630		
	11	Polygon	122292	12070104	1207010403	120701040309	23541		
	12	Polygon	122301	12040202	1204020204	120402020400	156240		
	13	Polygon	122302	12040104	1204010401	120401040103	17390		
	14	Polygon	122308	12040104	1204010403	120401040305	13048		
	15	Polygon	122310	12040104	1204010407	120401040701	26118		Ŧ
1								•	
1	• • 1	> >I 📔	🔲 (0 out	of 4159 Sel	ected)				
S	ubwatershed		,						

At the top left corner of the Table, click on the Select by Attributes tool



Click on "**HUC8**" and then "=" and then select "Get Unique Values" and from this select '**12100203**' click on the symbols to construct the entry

Select by Attributes
Enter a WHERE clause to select records in the table window.
Method : Create a new selection
OBJECTID_1 OBJECTID HUC_8 HUC_10 HUC_12
$\begin{array}{c c c c c c c c c c c c c c c c c c c $
HUC_8 = '12100203'
Clear Verify Help Load Save Apply Close

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.

										The state of the s
Tal	ble								×	生命承知的 自己
•	- 🔁 - 🖳 🖟	i 🕰 🖸 🎸	x I The The o	×						
		<u> </u>								
Sul	owatershed									
	OBJECTID_1 *	Shape *	OBJECTID	HUC_8	HUC_10	HUC_12	ACRES	NCONTRB	*	
Þ	100	Polygon	122319	12100203	1210020304	121002030406	31225			
	170	Polygon	123522	12100203	1210020305	121002030504	36726			
	184	Polygon	123617	12100203	1210020305	121002030503	32568		=	
	188	Polygon	123635	12100203	1210020304	121002030410	22111		-	的资本是因为自然
	192	Polygon	123663	12100203	1210020304	121002030408	11095			
	338	Polygon	226560	12100203	1210020304	121002030405	23122			ELECTRONIC DE LE
	364	Polygon	123640	12100203	1210020305	121002030501	36224			Real Provide States
	366	Polygon	123716	12100203	1210020303	121002030307	17548			REPARE 255
	367	Polygon	123717	12100203	1210020305	121002030502	31303			
Ш	373	Polygon	123741	12100203	1210020303	121002030306	34527			
	374	Polygon	123796	12100203	1210020303	121002030305	17845			
	375	Polygon	123798	12100203	1210020303	121002030308	21599			
	376	Polygon	123803	12100203	1210020304	121002030409	31249			
	377	Polygon	123810	12100203	1210020303	121002030303	21719			
	379	Polygon	123864	12100203	1210020303	121002030304	30953		Ŧ	CALL CONSTRUCT
1								•		AND CONTRACT OF CONTRACT
I	I I 1	ны 🗐	(32 out	of 4159 Se	elected)					
	· · ·		(52.00							

Use Selection/Zoom to Selected Features:



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



Be sure to navigate to where you established the SanMarcos geodatabase earlier and don't just accept the default geodatabase presented to you, which is somewhere deep in the file system that you may never find again! Browse inside the SanMarcos geodatabase you created to the **BaseData** Feature dataset and name this new feature class as **Subwatershed** and click **Save**. (Note that you may have to change the Save as Type to **File and Personal Geodatabase feature classes**).

Saving Data	X
Look in:	🖥 BaseData 🔹 🛧 🚖 🖓 🖓
Name:	Subwatershed Save
Save as type	File and Personal Geodatabase feature classes

At the next screen click OK



You will be prompted to whether add this theme to the Map, click **Yes**. In ArcMap, Use **Selection/Clear Selected Features** to clear the selection you just made.



And then Zoom to Layer to focus in on your selected Subwatersheds. Remove the original Subwatershed feature class from ArcMap so you can focus just on your selected ones. Change their symbology so that they are colored green if necessary. Watersheds are always green! Add a Topographic base map.



Use the Inquiry 💷 button to query the uppermost subwatershed in 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 **Properties/Symbology**. Select **Categories Unique** values and use **HUC_10** as the Value Field, hit **Add All Values** to give each HUC10 watershed a different color. Hit **Apply** and **OK** to get this color scheme applied to the map.

General Source Selecti	on Displa	y Symbology	Fields Defi	nition Query	Labels	Joins & Relate	es Time	H
how:	Draw ca	ategories using	1 unique va	ues of one	field	(Import	1
Features	Value De		y aniquo Ta	Color	Dama.	ί	inport	J
Categories	value Fie	DIG			катр			<u>.</u>
···· Unique values	HUC_10)		-			-	
- Unique values, many								
Match to symbols in a	Symbol	Value		label		Count		
Quantities	-,	s			>	0		
Linaris Multiala Attailudaa	✓	<pre>_<aii other="" pre="" values<=""></aii></pre>		all other valu	es>	0		
Multiple Attributes		<heading></heading>	1	100_10		32		
		1210020301	1	210020301		5		
		1210020302	1	210020302		5		
		1210020303	1	210020303		8		
4 III •		1210020304	1	210020304		10	-	
		1210020305	1	210020305		4		
	Add All V	alues Add Va	alues	Remove	Remove	e All Ad	vanced •	

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 **File/Save As** to save your map file as **Ex2.mxd** with the new information that you've created. Its good to ensure that your map document is in the same place as your data and that only local file references are made – this makes it easier to reconnect your map document with your data if you move them to another folder location. To do this, Select **Map Document Properties**

Q				
File	Edit View B	ookmarks	Insert	Selection Geop
	New		Ctrl+N	
1	Open		Ctrl+0	k 🕦 🖉
	Save		Ctrl+S	
	Save As			
-	Save A Copy			2 1
	Share As			·
	Add Data			•
8	Sign In			7
	ArcGIS Online]
	Page and Print Se	tup		0
	Print Preview			mon
÷	Print			
	Export Map			17
	Analyze Map			
8	Map Document P	roperties		
	1 Z:\giswr2015\Ex	Map Docu	ment Pro	operties
	2 Z:\NFIE\NWS\B	Display o	r edit the	properties of
	3 Y:\Projects\Nat	this map	documer	nt, such as
	Exit	specify w	hether di	sk-based data it
		uses will I pathnam	be referer es.	nced by relative

And at the bottom of the form that appears, Check the box next to **Store relative pathnames to data sources.**

Last Saved:	9/9/2015 9:53:48 PM	
Last Printed:		
Last Exported:		
Default Geodatabase:	C:\Users\maidment\Documen	ts\ArcGIS\Default.gc 🖻
Pathnames:	✓ Store relative pathnames t	to data sources
Thumbnail:	Make Thumbnail	Delete Thumbnail
	ОК	Cancel Apply

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 **BaseData** Feature Dataset in the **SanMarcos.gdb** Geodatabase in the location where you created it. It comprises Simple Features (no topology), that are Polygons (have X, Y values) but have no Z values or M values which deal with elevation and measure, respectively, that we'll encounter in a later exercises. It has a **Geographic Coordinate System** using the **North American 1983** datum. You'll learn more about these shortly also.

i 🔍 🔍 🖑 🥝 i 💥 🌔	Layer Properties
Table Of Contents	General Source Selection Display Symbology Fields Definition Query Labels Joins & Relates Time
☐ Subwatershe ☐ < Subwatershe ☐ <all other<="" p=""> HUC_10 121002030</all>	Extent Top: 30.167716 dd Left: -98.715418 dd Right: -97.435295 dd Bottom: 29.483408 dd
☐ 121002030 ☐ 121002030 ☐ 121002030 ☐ 121002030 ☐ 121002030 ☐ ☑ Basemap ☑ Ø World_To	Data Source Data Type: File Geodatabase Feature Class Database: C:\GISWR2015\Ex2\Soln\SanMarcos.gdb Feature Dataset: BaseData Feature Class: Subwatershed Feature Type: Simple Geometry Type: Polygon Coordinates have Z values: No Geographic Coordinate System: GCS North American 1983
	< b

You should be aware of this to manage the space on your computer or move to another computer and have access to the same data.

Creating a San Marcos Basin Boundary

It is useful to have a single polygon that is the outline of the San Marcos Basin. Click on the **Search** button in ArcMap and within the Search box that opens up on the right hand side of the ArcMap display, click on **Tools** and then type **Dissolve**. You will see the system gives you several options. Select **Dissolve** (**Data Management**)

Search +
🔶 🟠 🥭 🗄 👻 Local Search
ALL Maps Data Tools Images
dissolve
Any Extent
Search returned 7 items Sort By
Dissolve (Coverage) (Tool) Creates a new coverage by merging adja toolboxes\system toolboxes\coverage tool
Dissolve (Data Management) (Tool) Aggregates features based on specified at toolboxes\system toolboxes\data manage
Dissolve Network (Network Analyst) (Creates a network dataset that minimizes toolboxes\system toolboxes\network anal

You'll see a **Dissolve** tool window appear. 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** geodatabase. If you don't do this, the result will be called Subwatershed_Dissolve and will be stored in a default geodatabase location. That is ok, and you can subsequently export it to your San Marcos geodatabase as the feature class Basin. Hit Ok to execute the function.

N Dissolve		×
Input Features		~
Subwatershed	_ 🖻	
Output Feature Class		
Z:\giswr2015\Ex2\Soln\SanMarcos.gdb\BaseData\Basin	2	,
Dissolve_Field(s) (optional)		
I HUC_8	^	
HUC_10		
HU_10_GNIS		
HU_12_GNIS		
	~	
<	>	
Select All Unselect All	Add Field	
Statistics Field(s) (optional)		
OK Cancel Environments	Show Help	>>

There'll be no apparent activity for a while and then you'll see some blue scrolling text at the bottom right and a pop up indicating completion and the **Basin** will appear.

Lets alter the map display to make the **Basin** layer just an outline. Click on the Symbol for the Basin layer and select **Hollow** for the shape, Green for the **Outline Color** and 2 for the **Outline Width**.

⊇ ❷ 월 월 ≫ 1 1 1 2 × 1 ⊅ 2 Q (♥] ❹ ¥ 22 + → ₩	(~ ◆ - 1:1,000,000	Symbol Selector		D. L. Da		X
ple Of Contents 7	×	Type here to sea	arch	• @	🔊 🗄 🗸	Current Symbol
Layers Basin	679 m Gillespie	ESRI			styles	
 Subwatershed <all other="" values=""> HUC_10</all> 1210020301 1210020302 	655 m	Green	Blue	Sun	E	Fill Color:
	Gaad superior	Hollow	Lake	Rose		Outline Color:
		Beige	Yellow	Olive		Save As Reset

And you'll get a very nice looking map of the San Marcos Basin with its constituent subdrainage areas. Let's also remove the **Watershed_Dissolve** and **Subwatershed** feature classes since we don't need that any more in our map display. Right click on that feature class and select **Remove**



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.

When this table first opens you might see fewer than 8 digits in the HUC8 Field.

This occurs if the column display is too narrow. You can click between the headers to make it wider. This is an effect to be alert to because it is not obvious that the number you are seeing is wrong.

Tal	ble				
°	- 🗄 - 🔓	🔂 🛛 🚭	×		
Ba:	sin				
	OBJECTID *	Shape *	HUC8	Shape_Length	Shape_Area
Þ	1	Polygon	12100203	4.405801	0.32871

Save your ArcMap document to the file **Ex2Basin.mxd.** Note that this is a different name than used earlier, so you can retrieve the former configuration or this one separately.

Click on the **Catalog** window in ArcMap and navigate to your **BaseData** feature dataset. 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?

Land Cover Information for the San Marcos Basin

Now, we are going to use some of the new data services to find some land cover properties of the San Marcos basin. In ArcMap, sign in to ArcGIS Online

File	Edit	View	Bookmarks	Insert	Se			
	New			Ctrl+N				
2	Open			Ctrl+0				
H	Save			Ctrl+S				
	Save A	s						
	Save A	Сору						
	Share A	As .			•			
	Add Da	ata			۲			
	Sign In							
	A	<u>0 r</u>						
	– Sign	in or ou	it of ArcGIS Oi	nline.				
ArcGI	S Sign Ii GIS D	n Jesktoj Online	o wants to a	access	you	Ir Arce	sis	×
ArcGI	s sign Ii :GIS D Sign	esktop Online	o wants to a e account ir	access y formati	you		is is	×
ArcGI	s Sign II GIS D Sign	n Desktop Online	o wants to a e account ir	access y	you	ir ArcG	is	×
Arc	s Sign I GIS D Sign Jsern	esktop Online In ame	o wants to a e account in	access y	you	ir ArcG esr	i I	E
ArcGI	s Sign I GIS D Sign Jsern	esktop Online In ame	o wants to a e account in	access y	you	ir ArcG	ii	E
ArcGI	s Sign II GIS D Sign Jsern	n Online In ame vord	o wants to a e account in	access y	you	ir ArcG	ii i	E
ArcGI	s Sign I GIS D Sign Jsern	esktop Online In ame vord	o wants to a e account in	access	you	esr	i i	E
ArcGI	s Sign I GIS D Sign Jsern	esktop Online In ame vord	o wants to a e account in	access	you	esr	i i	

In ArcCatalog, select Add GIS Server and accept Use GIS Services

🖃 🙀 Home - Ex2\Soln	
🗆 🧊 SanMarcos	
🖃 🖶 BaseData	
🖾 Basin	
🖾 Watershed	
💽 Ex2	
🗶 ex2	What would you like to do?
Ex2Basin	
🛣 ex2basin	
🗄 🖬 Folder Connections	Se dia services
🗄 📷 Toolboxes	Publish GIS services
🗄 🗊 Database Servers	0.1
🗄 🛱 Database Connections	Administer GIS server
🖃 🗊 GIS Servers	
Add ArcGIS Server	
🝓 Add ArcIMS Server	
🔙 Add WCS Server	
🍓 Add WMS Server	
🝓 Add WMTS Server	

For the server URL use <u>http://landscape2.arcgis.com/arcgis/</u> Enter your ArcGIS Online User Name and Password and hit Finish. (Note that on earlier versions of ArcGIS you may need to include the word services in the URL <u>http://landscape2.arcgis.com/arcgis/services</u>.)

neral		
Server URL:	http://landscape2.arcgis.com/arcgis	
	ArcGIS Server: http://gisserver.domain.com:6080/arcgis	
-Authentication (Opti	ional)	
User Name:	YourESRIUserName	
Password:	•••••	
	Save Username/Password	
About ArcCIS Server (

If you click on the + sign on the service that appears, you'll see an entry for **USA_NLCD_2006.** This is the USGS Land Cover raster map of the United States.



Drag the USA_NLCD_2006 layer into your 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 to the bottom of the map, Austin to 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.



In order to do the next computation, you must have the Spatial Analyst extension of ArcGIS active. Click on **Customize/Extensions** and make sure that **Spatial Analyst** is checked on

Custo	omi	ize Windows Help
	То	olbars 🔹 🎦 🎥 🖉
	Ext	ensions
	Ad	Extensions
	Cu	Select the ArcGIS Desktop
	Sty	extensions you want to use. Extensions provide extended
	Are	capabilities and usually require
1	ę -	that you have a license to use them. The dialog lists the
		extensions that are currently
S. C.		installed on your system and
	6	which work with the application
S. 10		you are currently using.

Exte	ixtensions									
Se	elect the extensions you want to use.									

Use the **Search** tool in the top right of the ArcMap screen, and search for **Extract**, selecting the **Extract by Mask** tool. If you don't see this tool in ArcMap use **Windows/Search** in ArcMap to add it:



Search + 2						
< 🔶 🚰 😂 🗉 🔻 Local Search						
ALL Maps Data Tools Images						
extract						
Any Extent 💌						
Search returned 37 items Sort By						
Extract by Attributes (Spatial Analyst) Extracts the cells of a raster based on a l toolboxes\system toolboxes\spatial analys						
Extract by Points (Spatial Analyst) (Tool) Extracts the cells of a raster based on a toolboxes\system toolboxes\spatial analys						
Extract by Mask (Spatial Analyst) (Tool) Extracts the cells of a raster that corresp toolboxes\system toolboxes\spatial analys						

Click on the **Extract by Mask** tool, and use USA_NLCD_2006 as the Input Raster, Basin as the mask data and put the result in the SanMarcos geodatabase with the name LandCover. This is being stored as a raster in the geodatabase so it does not go inside the Feature Dataset (which only holds vector feature classes).

K Extract by Mask	
Input raster	A
USA_NLCD_2006	
Input raster or feature mask data	
Basin	
Output raster	
C:\GISWR2015\Ex2\Soln\SanMarcos.gdb\LandCover	

You'll see the blue text cycling along at the bottom of the screen as the data extraction continues and then the result appears in ArcMap 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, you'll see it is a raster with 30m x 30m cells (these are derived from 30m Landsat imagery).

	,,	Buon	Dispidy	cymoology						
Property		Va	alue							
Raster Infor	mation									
Columns and	Rows	4	750, 2927							
Number of Ba	nds	1	1							
Cell Size (X, Y)	3	30, 30							
Uncompresse	d Size	1	13.26 MB							
Format		F	FGDBR							
Source Type		G	Generic							
Pixel Type		si	signed integer							
Pixel Depth		8	8 Bit							
Data Source										
Data Type:	File	Geodata	base Rast	er Dataset						
Database:	C:\(SISWR20	15\Ex2\So	oln\SanMarco	s.gdb					
Raster:	Lan	dCover								

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

Table											
🗄 • 🖶 • 🏪 🌄 🖾 🐠 🗙											
LandCover											
Г	OBJECTID_1 *	OBJECTID	Value	Red	Green	Blue	Opacity	Count	LC_CLASS		
Þ	• 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		
L	5	6	23	0.93	0	0	1	20018	Development		
	6	7	24	0.67	0	0	1	9046	Development		
L	7	8	31	0.7	0.68	0.64	1	8890	SnowlceBarren		
	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	164114	ShrubScrubGrass		
	12	13	71	0.89	0.89	0.76	1	603736	ShrubScrubGrass		
L	13	14	81	0.86	0.85	0.24	1	698328	Agriculture		
L	14	15	82	0.67	0.44	0.16	1	303988	Agriculture		
L	15	16	90	0.73	0.85	0.92	1	106772	Wetland		
L	16	17	95	0.44	0.64	0.73	1	2679	Wetland		
	I ← 1 → → I I I (0 out of 15 Selected) LandCover										

Right click on LC_Class and select Summarize



Expand the **Count** field and check **Sum**, save the result as a table called **Summary**

Summ	arize
Sumn of the	narize creates a new table containing one record for each unique value e selected field, along with statistics summarizing any of the other fields.
1.	Select a <u>fi</u> eld to summarize:
	LC_CLASS
2.	Choose one or more summary statistics to be included in the output table:
	E Green
	Biue Opacity
	E Count
	Minimum
	Maximum
	Standard Deviation
	▼
3.	Specify output table:
	C:\GISWR2015\Ex2\Soln\SanMarcos.gdb\Summary
	Summarize on the selected records only
Abou	t summarizing data OK Cancel

The computation will proceed and add the Summary table to your ArcMap 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.



Tal	Table 🗆 🗆 🗙									
•	🖾 - 🖶 - 🖳 🔂 🖾 🐗 🗙									
Summary >										
	OBJECTID *	LC_CLASS	Count_LC_CLASS	Sum_Count						
Þ	1	Agriculture	2	1002316						
	2	Development	4	481696						
	3	Forest	3	1350247						
	4	OpenWater	1	22455						
	5	ShrubScrubGrass	2	2244878						
	6	SnowlceBarren	1	8890						
	7	Wetland	2	109451						
1	I ← ← 1 → → I I ■ □ (0 out of 7 Selected)									
La	ndCover Sum	mary								

Save your map as Ex2LandCover.mxd.

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 NFIEGeo_12.gdb and add the Flowlines and Catchments to your ArcMap display. Turn off the LandCover distribution.



Color your Catchments as hollow with a green outline and your Flowlines as nice blue streams.



Now, let's select the features from our large dataset that lie within our Basin. In ArcMap, use **Selection/Selection by Location**



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



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

		123	
Agriculti Wetland	Data 🕨	ਿ	Repair Data Source
Summary	Save As Layer File	\diamondsuit	Export Data
🖃 间 C:\GISWR2015' 🌍	Create Layer Package		Export Data
😑 🖶 Geographic	Properties		M Save this laver's data as a shapefile
	APAK & KORA		Vi or geodatabase feature class
🖃 🗹 Catchment		Ð	Review/Rematch Addresses



Clear the Selected Features, then repeat this procedure for selecting the **Catchment** features that lie within the San Marcos basin. Remove the large coverages of Flowline and Catchment that you started with and display only the Flowlines and Catchments within the San Marcos Basin.



This process isn't quite so clever as for the land cover distribution – you have to recolor the newly added Flowlines and Catchments to make them blue and green respectively. 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 **Properties/Symbology**. Use **Graduated Symbols** with **Value Q0001C** and click on **Template** to change the base color to blue.

Ha	tches		Joins & Relates			e		HTML Popup		
General	Source	Selection	Display	Symbology	Fields	Definition	Query	Routes		
ow:			ition union (umbol aizo ta	abow ml-	tivo voluce		moort		
eatures			ittes using :	symbol size to	Show rea			mpon		
Categories		Fields				assification				
Juantities		<u>V</u> alue:	Q0001C		•	Natural Br	eaks (Jenk	ts)		
Graduat	ed colors	Normalization	none		- Cl	a <u>s</u> ses: 5	- <u>C</u> la	ssify		
Proportio	ed symbols									
harts	nar symbols	Symbol Size fro	om: 0.5	to: 4						
Aultiple A	tributes						Te	mplate		
		Symbol Ra	nge	Lab	el					
		0.00	-							
		10.4	413001 - 34.8							
		34.8	898001 - 67.5							
yes m	2 6	67.	549001 - 115.							
SCX.	원 🌾									
n an	ž 💭	3								
よう										
$\mathcal{D}_{\mathcal{C}}$	┍╲╸	Show class	ranges using	fastura values	ĺ	Advanced	•			
Y	ŤΓΛ	Cidas	ranges using	reature values	ί	//avanco <u>a</u>				

Turn on the display for the Subwatershed feature class. Now you've got a much more interesting map with the main river, called upstream the Blanco River and then downstream the San Marcos River. The tributary on the east side of the basin is Plum Creek. This is all laid out over a subdivision of the San Marcos basin by the HUC10 Watersheds.



If you open up the **Catchment Attribute Table** and right click on the **AreaSqKm** attribute, you can determine the statistics of the Catchment areas.

Basenara	Davy.	B	lanco		Ser and	The second	Constant of	1	1 Cn MY MC 2	5.2		
Flowline	T	able										
Q0001C	2000											
	S 🖉 C	Catchment X St.										
		OBJECTID *	Shape *	GRIDCODE	FEATUREID	SOURCEFC	AreaSo	1/11	Shana Longth Shana Ar	rop		
	18 8 F	1	Polygon	1643451	1628237	NHDFlowline	1.6	<u>a</u> .	Sort Ascending			
	2. 60	2	Polygon	1643610	1628261	NHDFlowline	7.1	₹.	Sort Descending			
Catchment	Ken	3	Polygon	1643658	1630611	NHDFlowline	39.8		Advanced Sorting			
	123	4	Polygon	1643678	1630203	NHDFlowline	0.1		Advanced Sorting			
🗖 🔽 Basin		5	Polygon	1643697	1633013	NHDFlowline	3.1		Summarize			
		6	Polygon	1643712	1633015	NHDFlowline	0.0	Σ	Statistics			
	- Kal	7	Polygon	1643751	1628255	NHDFlowline	9.4			1		
	2m	8	Polygon	1643752	1633027	NHDFlowline	0.0		Statistics			
all other values>	1.	(<u> </u>	Delveen	4649047	1000000	MUDEloudino	· ^					
HUC_10	1.00								Generates a report of statistics for	r		
1210020301	1882	14 4	• • •		ut of 555 Select	ted)			field. This command is disabled it	1C :4		
1210020302	(Catchment							this field is not numeric. If any of	e F		
1210020303	rinment						1001151		the records in the table are			
1210020304	(on St	()	9	ity Sche	rtz	har	The	×	currently selected, statistics will			
1210020305	al Area	524	- Co	nueree		Guadalup	e	M	only be generated for the selected	d		
LandCover	1 Alexandre	55	SCO	ilverse	ang			100	records.			

You can similarly summarize the attributes of **Flowline** feature class, such as the **LengthKm** attribute.

C:\GISWR2015\Ex2\Soln\SanN G BaseData	LI	bj National Hist Pk	lanco	State Park		A	stin fen a		5			
🖃 🗹 Flowline	1844	Table										
Q0001C	1962 3											
	1000											
	F 🖉 F	Flowline × Sta										
		RESOLUTION	GNIS_ID	GNIS_NAME	LENG	ГНКМ		WE 🔺	trop			
	8.84	Medium	1344268	Plum Creek		1	Sort Ascending		1			
— 115.960001 - 224.133	2. 60	Medium	1373135	Clear Fork Plum Creek	1	7	Sort Descending		See.			
Catchment	Ken	Medium	1352181	Big West Fork Plum Creek			Advanted Section		23			
	1995	Medium	1374036	Hemphill Creek	1		Advanced Softing		1			
	1400	Medium	1331430	Brushy Creek			Summarize		12%			
	1000	Medium	1331658	Bunton Branch		5	Chartistics		-			
		Medium	1332102	Canoe Creek	1	4	Summarize	1	2			
Subwatershed		Medium	1333334	Copperas Creek			Samuel	—	~			
all other values>	2 m >	Madium	1004050	Der Creek	1		Create a summary table grouped		1			
HUC_10	BYSA!	•					by the values in this field. The	•	26			
1210020301	(AND THE	14 4) > >	🔲 🔲 (0 out of 557 Selected)			dialog that appears lets you		-			
1210020302	1.995.3 T	Flowline					choose whether all the records will		250			
1210020303	roment		_				selected records		14			
1210020304	on St		9	ity Schertz	m	×	Sector records.	14.50				

Use the Basemap to find the town of Wimberley near the upper end of the basin



You can use the **Select** tool to select a flowline, such as the one labelled with **COMID** = 1630223 (be sure to expand the field so you can see all the numbers in it) as shown in the diagram. If you similarly select the Catchment in this area, you'll see



That the Catchment has FeatureID = 1630223. It is this COMID-FEATUREID association that makes the NHDPlus such a powerful dataset --- each stream feature has a unique area associated with it, and that is true over the whole United States. This is the basic association that we've used for the National Flood Interoperability Experiment.

Clear the Selected Features, and Zoom to Layer for the Basin feature class to get back the original extent of our map.



Now let's create a map and do some summarization of watershed attributes. Right click in the grey area at the top of ArcMap to the right of the menu bars. Open the **Draw** Toolbar

_		(Beer		3D Analyst
Customize	ustomize Windows Help			Advanced Editing
Toolba	rs	•		Animation
Extensi	Extensions			ApUtilities
Add-In	Manager			Arc Hydro Groundwater Toolbar
Custon	nize Mode			ArcScan
Style M	lanager			COGO
ArcMa	n Ontions			Data Driven Pages
				Data Frame Tools
15 111 A				Distributed Geodatabase
month			~	Draw

And select a **Callout** tool



Click somewhere on the Blanco River and drag the callout away to create a connection with that point. Type in **Blanco River** as the text. Do the same for the other two main rivers in the map, the San Marcos River and Plum Creek.

Save your map document as Ex2Flow.mxd



To be turned in: Make a map of the San Marcos basin with its labelled 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
08171000	Blanco Rv at Wimberley, Tx	29° 59' 39"	98º 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	29º 41' 58"	97º 36' 12"	309	114
08172000	San Marcos Rv at Luling, Tx	29° 39' 58"	97º 39' 02"	838	408
08170500	San Marcos Rv at San Marcos, Tx	29° 53' 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 using the formula

Decimal Degrees (DD) = Degrees + Min/60 + 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.xlsx**. Close Excel before you proceed to ArcMap.

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	29º 41' 58"	97º 36' 12"	29	41	58	97	36	12	29.6994	-97.6033	309	114
08172000	San Marcos Rv at Luling, Tx	29° 39' 58"	97º 39' 02"	29	39	58	97	39	2	29.6661	-97.6506	838	408
08170500	San Marcos Rv at San Marcos, Tx	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 **ArcMap** and the **Ex2Flow.mxd** file you created earlier in this exercise. Select the add data button \blacklozenge and navigate to your Excel spreadsheet



Double click on the spreadsheet to identify the individual worksheet within the spreadsheet that you want to add to ArcMap (it's a coincidence that they have the same name in this example and that is not necessary in general).

Add Data						×
Look in:	🖻 latlong.xlsx	▶ 🖒		•	21	
Ⅲ_xlnm# Ⅲ latlong\$:Database \$					

Hit **Add** and your spreadsheet will be added to ArcMap. Pretty cool!! Its always been a struggle to add data from spreadsheets before and it seems like at ArcGIS 10, they have gotten this right. If you have trouble with this step, save the Excel file as a .csv format and add it that way.

Ta	able												×
0													
la	tlong\$												×
Г	Latitude	Longitude	LatDeg	LatMin	LatSec	LongDeg	LongMin	LongSec	LatDD	LongDD	DASqMile	MAFlow	
Þ	29 39" 39"	98□ 05' 19"	29	59	39	98	5	19	29.994167	-98.088611	355	142	
	29 58' 45"	97 🗆 54' 35"	29	58	45	97	54	35	29.979167	-97.909722	412	165	
E	29 0 55' 22"	97 0 40' 44"	29	55	22	97	40	44	29.922778	-97.678889	112	49	
E	29 41' 58"	97 🗆 36' 12"	29	41	58	97	36	12	29.699444	-97.603333	309	114	
E	29 39' 58"	97 🗆 39' 02"	29	39	58	97	39	2	29.666111	-97.650556	838	408	
E	29 0 53' 20"	97 056' 02"	29	53	20	97	56	2	29.888889	-97.933889	48.9	176	
Γ													
1													Þ.

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

(2) Right click on the new table, latlong\$, and select Display XY Data



(3) Set the X Field to **LongDD**, the Y Field to **LatDD**, Note that by default a GCS_North_American_1983 coordinate system is chosen. This is correct for this dataset. You could use Edit to change it if the coordinate system of the input data was different.

Display XY Data			×
A table containin map as a layer	g X and Y coor	dinate data can	be added to the
Choose a table fr	rom the map o	r browse for and	ther table:
Sheet1\$			_ 6
Specify the field	ds for the X, Y	and Z coordinat	es:
X Field:	LonDD		•
Y Field:	LatDD		•
Z Field:	<none></none>		-
Coordinate Sys Description: Geographic C Name: GCS	tem of Input (oordinate Sys North_Americ	Coordinates tem: an_1983	
			4
Show Detai	ils		Edit
📝 Warn me if th	e resulting lay	er will have restr	ricted functionality
About adding XY	<u>data</u>	ОК	Cancel

Hit **OK**, to complete it and you'll get a warning message about your table not having an ObjectID. Just hit Ok and 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 **Latlong\$Events** (or possibly Sheet1\$events) and **Export Data** to convert the points into a **Gages** feature class in the San Marcos Geodatabase, as you did earlier with Basin and Watershed.



Add the resulting Gages to your map and recolor and resize them so you can see them clearly.



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. It can occur that some

labels don't show up because they display where you've got your Watershed Callouts created earlier. Drag those Callout boxes to another location and the gage labels will appear.



To resize the labels, right click on **Gage** and select **Properties/ Labels**, and then select 12 point type.

ayer Properties	<u>-</u>			
General Source Select	tion Display Symbolog	y Fields Definition Qu	ery Labels	Joins & Relates Tir
Label features in this	layer			
Method:	abel all the features the sa	me way.	-	
Text String Label Field:	SiteName	incu.	•	Expression
Text Symbol				
AaB	BbYyZz	Arial	 ▼ 12 ▼ 10 	
Other Options	nerties Cos	Pre	-defin 11 12 14	tyle

Open the **Attribute Table** of the **Gages**, and right click on the fields that you really don't need to see and hide them.

1	Sort Ascending								
	Sort Descending								
	Advanced Sorting								
	Summarize								
Σ	Statistics								
**	Field Calculator								
	Calculate Geometry								
	Turn Field Off								
	Freezo/Unfreezo Column								
×	Turn Field Off								
889	Turns this field off so it is not shown here or in any other dialogs.								

Make a display like that shown below.



Linear Referencing the Stream Gages

Now, let's locate the gages on the Flowlines. Zoom in to the location of the Blanco River at Wimberley and query the Flowline there. You'll see it has a **ReachCode** value of **12100203000084**. This means that it is river segment 84 in the HUC8 Subbasin 12100203. The EPA and USGS have similarly labelled all the river and stream reaches in the nation.

Identify		×	-
Identify from:	<top-most layer=""></top-most>	• 12 - 12 - 12 - 12 - 12 - 12 - 12 - 12	
⊡ - Flowline Blanco	River	K	Annual Providence
			Planca
Location:	-98.086562 29.993972 Decimal Degrees		
Field	Value	- 7-	+ Ra
OBJECTID	358	- Stalve	h
Shape	Polyline ZM	-	STO N
COMID	1630223	imberley	YARGUM
EDATE	7/2/1999		Diana
FUATE			
RESOLUTION	Medium	2	A Start Start
RESOLUTION GNIS_ID	Medium 1372625	- 51	255
RESOLUTION GNIS_ID GNIS_NAME	Medium 1372625 Blanco River	- 53	- Cont
RESOLUTION GNIS_ID GNIS_NAME LENGTHKM	Medium 1372625 Blanco River 2.055	53	and the second
RESOLUTION GNIS_ID GNIS_NAME LENGTHKM REACHCODE	Medium 1372625 Blanco River 2.055 12100203000084		and the second

Use Search to locate Linear Referencing tools and select Locate Features Along Routes



Fill out the resulting table as shown:

Input Features					_
Gages				-	2
Input Route Features					
Flowline				-	2
Route Identifier Field					
REACHCODE					•
Search Radius					
		200	Meters		•
Output Event Table					
C:\GISWR2015\Ex2\Soln\SanMarcos	gdb\Address				2
Output Event Table Properties					
Route Identifier Field					
ReachCode					•
EventType					
POINT					-
Measure Field					
MEAS					•
To-Measure Field					
					-
Keep only the closest route location	n (optional)				

And you'll see a table called **Address** show up in your map display that has ReachCode and Measure locations for all your gages. This "addresses" them on the nation's stream network so that we know where they are.

<pre> <all other="" values=""> HUC_10 1210020301 1210020302 1210020303 1210020304 1210020305 LandCover LC_CLASS OpenWater</all></pre>	r gathleben Rd			Rade	Rd	3 Wimbe	A rley	Blanco Rv at Wimberley, Tx	Contraction of the second	a stand to	
Development		Table									1
SnowIceBarren											1
Forest			KA CH Gim M							-	1
ShrubScrubGrass		Address								×	1
Agriculture		OBJECTID *	ReachCode	MEAS	Distance	GageNo	SiteID	SiteName	Latitude	TU	
Wetland	IPN	• 1	12100203000084	68.589916	-0.000408	6	08171000	Blanco Rv at Wimberley, Tx	29 59' 39"	98:	
Summary	1	2	12100203000077	48.807631	-0.00006	5	08171300	Blanco Rv nr Kyle, Tx	29 58' 45"	97:	
Address	55	3	12100203000028	94.669251	0.000367	4	08172400	Plum Ck at Lockhart, Tx	29 55' 22"	97:	
C\GISWR2015\Ev2\Solp\latlor		4	12100203000015	17.618976	-0.0004	2	08173000	Plum Ck nr Luling, Tx	29 41' 58"	97:	
	1785	5	12100203000050	79.925134	-0.000184	3	08172000	San Marcos Rv at Luling, Tx	29 39' 58"	97:	

OpenWater		A A	R. SUF	Ex >			A				
SnowIceBarren		able 🗐 🗸 📑 🗸 🏊	N 1 4 ×								
Forest ShrubScrubGrass ■	A	Address									
Agriculture		OBJECTID *	ReachCode	MEAS	Distance	GageNo	SiteID	SiteNa			
Wetland	RN	• 1	12100203000084	68.589916	-0.000408	6	08171000	Blanco Rv at Wimberley			
Summary	and the second	2	12100203000077	48.807631	-0.00006	5	08171300	Blanco Rv nr Kyle, Tx			
Addre	SPT	3	12100203000028	94.669251	0.000367	4	08172400	Plum Ck at Lockhart, Tx			
Ch GISWE Open		4	12100203000015	17.618976	-0.0004	2	08173000	Plum Ck nr Luling, Tx			
C. (015W) Loins and Relates		5	12100203000050	79.925134	-0.000184	3	08172000	San Marcos Rv at Lulin			
		6	12100203000131	83.03968	-0.000417	1	08170500	San Marcos Rv at San			
• X Remove		•		111							
World_Tq Data	•	IA A _ 1	1 🔸 🖬 📃 🗖	(0 out of 6	5 Selected)						
Edit Fea Display Ro	oute Event	ts									
Geococ Adds a n	ents from a	yer based on									
🕂 Display											

Display Route Events								
Route events are objects with locations measured along routes. A table containing route events can be added to the map as a layer.								
Specify the routes referenced by the events in the table								
Route Reference: Flowline								
Route Identifier: REACHCODE								
Specify the table containing the route events								
Choose a table from the map or browse for another table.								
Event Table:								
ReachCode								
Choose the type of events the table contains:								
<u> <u> P</u>oint Events: Occur at a precise location along a route </u>								
\bigcirc Line Events: Define a discontinuous portion of a route								
Choose the measure field for point events:								
Measure: MEAS -								
Choose the offset field. Events can be offset from their routes.								
Offset:								
Wam me if the resulting layer will have restricted functionality								
Advanced Options OK Cancel								

I have colored in the resulting Address Events in Green and used the Attribute Selection on Flowlines to select those with ReachCode = 12100203000084. The Measure value of 68.59 for this location means that the Green point is 68.59 % of the distance upstream from the downstream end of this flowline (the flow goes from left to right in this picture). As you can see, the Address Event is located right on the Flowline, not a little way off as the latitude and longitude of the gage would have indicated (and these values might be at the gage house which is a little way from the stream itself. In this manner, you can see how Linear Referencing provides precise location on the stream network of stream gages or other point features (you can also do Linear Referencing for line features that stretch from one point on a line to another).



Save your map as **Ex2Gages.mxd**.

Flow Data for the Blanco River

Open the CUAHSI data viewer <u>http://data.cuahsi.org</u> Enter the location Wimberley, Texas in the box in the upper left corner.



In the top right hand corner, select a Date Range of May 1, 2015 to present



So the Date Range is set at:

Select Date Range								
From: 05/01/2015								
то:	09/10/2015							
Select Keyword(s)								

Select a Keyword for **Discharge**

Please select your Keyword(s) (No selection searches all)										
Most Common Full List										
Actual Evaporation	Precipitation									
Air Temperature	Snow Water Equivalent									
🗹 Discharge	Soil Moisture									
Dissolved Oxygen	Specific Conductance									
Groundwater Level	Total Suspended Solids									
Nutrient	Water Temperature									
🔲 pH										
		Save								

Select a Data Service



Put **NWIS** in the Search Box in the top right hand side and select **NWIS Unit Values** as your data service (real-time instantaneous data).

Click to select Data Services × (No selection searches all) Select all non-gridded data services.											
Show 10 • entries	Clear Selection(5)						Search: N\	VIS		
Organization	$\stackrel{\wedge}{\nabla}$	Title		Sites	÷ v	ariables	¢	Values	4	ID	÷
U.S. Geological Survey		NWIS Daily Values		34841	48	4		387092632		1	
U.S. Geological Survey		NWIS Ground Water Level		232505	15			1960785		8	
U.S. Geological Survey		NWIS Unit Values		137915	14	13		30961052		3	
Organization		Title		Sites	v	ariables		Values		ID	
Showing 1 to 3 of 3 entries	(filtered from 102 f	otal entries)						Pr	evious	1	Next

Search the map and you'll see the gage at Wimberley highlighted



Click on the gage and select one of the two series that are listed and hit Process Selection

List of Timeseries near: 134 Malone Dr, Wimberley, TX 78676, USA To zip one or more data files, please click the associated table row(s) and then click the 'Process Selections' button.										
Show 10 • entries Select Top 25? Clear Selection(s) Process Selection Search:										
Organization	•	Service Name	$\stackrel{\wedge}{\nabla}$	Keyword	\$	Variable Name	$\stackrel{\wedge}{=}$	Site Code	÷	Variable Code
U.S. Geological Survey		NWISUV		Discharge, stream		Discharge, cubic feet per second		NWISUV:081710	00	NWISUV:00060
U.S. Geological Survey		NWISUV		Discharge, stream		Discharge, cubic feet per second		NWISUV:081710	00	NWISUV:00060
•										
Filter by: Organization	•	Filter by: Service N	ame 🔻	Filter by: Keyword	¥	Filter by: Variable Name	۲	SiteCode		VariableCode
Showing 1 to 2 of 2 entries Previous 1 Next										

You can see the progress of your download request in the Download Manager

You'll get a local Excel file downloaded to your computer. Open this and select the **Local Time** and **Discharge** fields

1	А	В	С	D	E
	Organization	SourceDescription	SourceLin	VariableN	VarU
	unknown	unknown	unknown	Discharge	unkn
	UTCTimeStamp	LocalTimestamp	UTCOffset	Value	Value
	5/1/2015 0:00	5/1/2015 0:00	0	67	
	5/1/2015 0:15	5/1/2015 0:15	0	67	
	5/1/2015 0:30	5/1/2015 0:30	0	67	
	5/1/2015 0:45	5/1/2015 0:45	0	67	
	5/1/2015 1:00	5/1/2015 1:00	0	67	
	5/1/2015 1:15	5/1/2015 1:15	0	67	
)	5/1/2015 1:30	5/1/2015 1:30	0	67	
	5/1/2015 1:45	5/1/2015 1:45	0	67	
!	5/1/2015 2:00	5/1/2015 2:00	0	67	
1	5/1/2015 2:15	5/1/2015 2:15	0	67	
ŀ	5/1/2015 2:30	5/1/2015 2:30	0	67	
	E la locate o de	5 /4 /2004 5 2 45	~		

Format the cells in the first column to show Date/Time

Α	В	С	I
LocalTimestamp	Discharge,	, cubic fee	per
5/1/15 12:00 AM	67		
5/1/15 12:15 AM	67		
5/1/15 12:30 AM	67		
5/1/15 12:45 AM	67		
5/1/15 1:00 AM	67		
5/1/15 1:15 AM	67		
5/1/15 1:30 AM	67		
E /1 /1E 1.4E AM	67		-

And plot a chart of the flow of the Blanco River at Wimberley



To be turned in. Make a map showing the labeled gages and their attribute table. Zoom into each of your gages, and compare the Drainage Area and the Mean Annual Flow from between the gage values and those given as Q0001C and Q0001E on the NHDPlus Flowline feature class. Prepare a table for your six gages which shows these comparisons. Discuss your results. Groundwater flow plays a role in this basin as there is a big discharge from the Edwards aquifer in a spring at San Marcos. Determine the distance in Km that each gage is upstream of the most downstream point of the reach on which it is located. Show a chart of the flow of the Blanco River at Wimberley. Notice the huge flood that occurred on this river – a 40 ft wall of water passed through the town of Wimberley during Memorial Weekend, 2015

Ok, you're done!

Summary of Items to be Turned in:

- 1. Make a map of the San Marcos basin with its HUC-10 and HUC-12 watersheds and subwatersheds. How many HUC-10 and HUC-12 units exist in the San Marcos Basin?
- 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 labelled 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. Make a map showing the labeled gages and their attribute table. Zoom into each of your gages, and compare the Drainage Area and the Mean Annual Flow from between the gage values and those given as Q0001C and Q0001E on the NHDPlus Flowline feature

class. Prepare a table for your six gages which shows these comparisons. Discuss your results. Groundwater flow plays a role in this basin as there is a big discharge from the Edwards aquifer in a spring at San Marcos. Determine the distance in Km that each gage is upstream of the most downstream point of the reach on which it is located. Show a chart of the flow of the Blanco River at Wimberley. Notice the huge flood that occurred on this river – a 40 ft wall of water passed through the town of Wimberley during Memorial Weekend, 2015