CEVE Hydrology Lab 1

This guide was created by the staff of the GIS/Data Center at Rice University and is to be used for individual educational purposes only.

The steps outlined in this guide require access to ArcGIS Pro software and data that is available both online and at Fondren Library.

The following text styles are used throughout the guide:

Explanatory text appears in a regular font.

1. Instruction text is numbered.
2. Required actions are underlined.
3. **Objects of the actions are in bold.**

Folder and file names are in italics.

Names of Programs, Windows, Panes, Views, or Buttons are Capitalized.

'Names of windows or entry fields are in single quotation marks.'

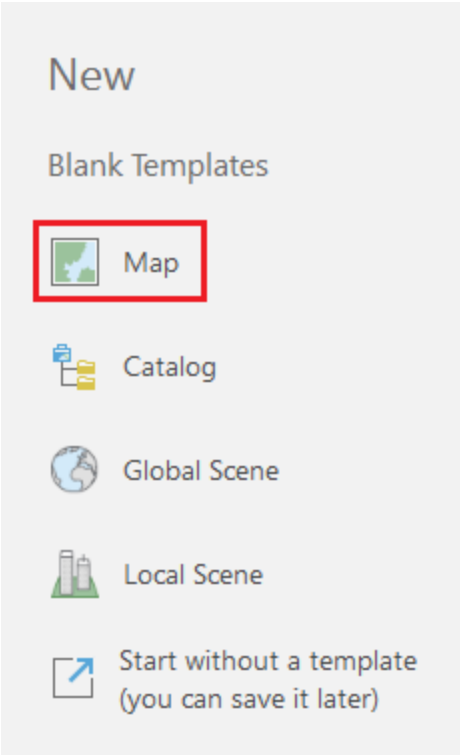
"Text to be typed appears in double quotation marks."

The following step-by-step instructions and screenshots are based on the Windows 10 operating system with the Windows Classic desktop theme and ArcGIS Pro 3.2.0 software. If your personal system configuration varies, you may experience minor differences from the instructions and screenshots.

In this lab, you will practice downloading, manipulating, mapping, and analyzing publicly available hydrology data from a variety of online websites to study the Buffalo-San Jacinto watershed subbasin, which encompasses the greater Houston region. Specifically, you will work with watershed and flowline data from the National Flood Interoperability Experiment (NFIE), stream gauge data from the National Water Information System (NWIS), and soils data from the Soil Survey Geographic Database (SSURGO).

Part 1: Creating a New GIS Project

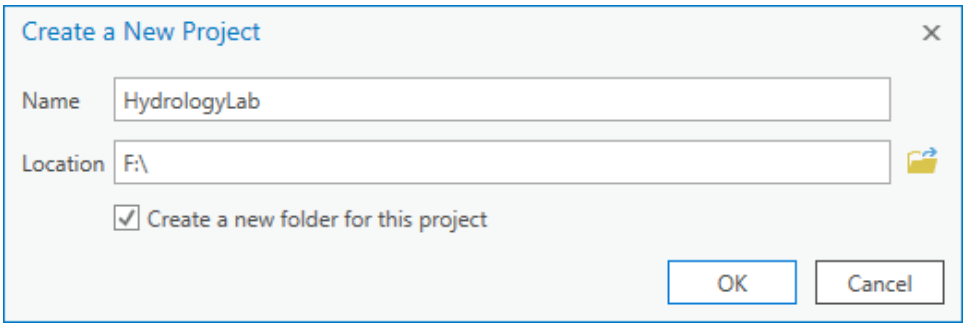
1. On the Desktop, click the **Start** menu and select **ArcGIS** > **ArcGIS Pro**.
2. If the 'ArcGIS Sign In' window appears, sign in using your **Rice organizational account**. (Detailed Instructions)
3. In the 'ArcGIS Pro' window, under the 'New' section, select the **Map** template.



4. In the 'Create a New Project' window, for 'Name', type " ***HydrologyLab*** ".
5. For 'Location', click the **Browse** button.
6. Navigate to the **location** in which you would like to store your *HydrologyLab* project folder and click **OK**.

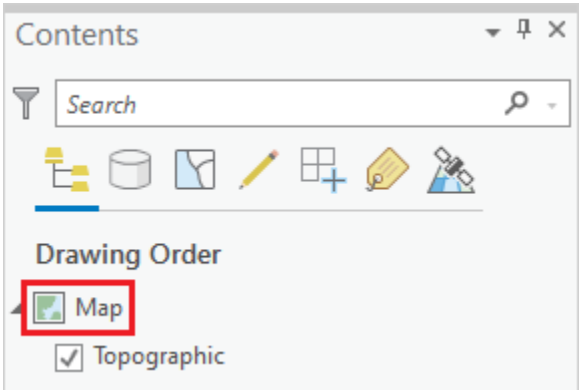
> A *project* folder is where you will store all of the files associated with this lab assignment. When working in a public computer lab environment, we recommend saving your work on an external USB drive. If you wish to nest your *project* folder inside other folders on your USB drive, or if you are using the hard drive on personal computer, ensure **that no spaces or special characters are used anywhere** along the entire file path of your *project* folder. The default project location on your personal computer is C:\Users\[*username*]\Documents\ArcGIS\Projects.
>
> In order to connect to a folder, you often have to be able to select the folder from the file browser on the right, rather than in the Navigation pane on the left. For example, if you wanted to store the project on an external USB F:\ drive, you would need to single-click Computer in the Navigation pane on the left and then single-click F:\ in the file browser on the right.

7. Once the *HydrologyLab* folder is selected, click **OK**.
8. Ensure **Create a new folder for this project** is checked.
9. Click **OK**.



Because you created a new project using the Map template, the project opens with a single map already created; however, it is generically named *Map*, so you will give it a more descriptive name to differentiate it from the maps created in future labs.

1. In the Contents pane, click ***Map*** once to select it. Then, click directly on the ***Map*** text a second time and rename it " ***Lab1Hydrology*** ".



Part 2: Mapping Watershed Data

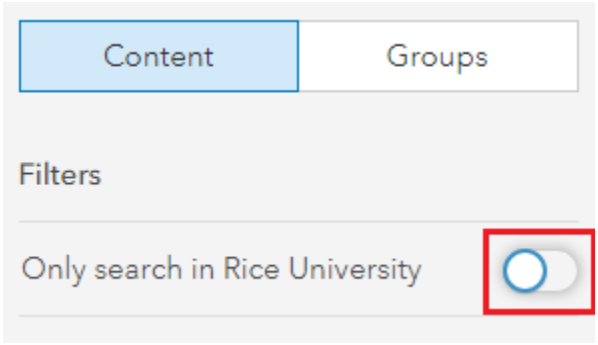
Downloading NFIE data

Your *project folder* and *geodatabase* have been created, so you are ready to download your first set of online GIS data. You will start by downloading data from the National Flood Interoperability Experiment (NFIE), which is searchable on the ArcGIS Online platform.

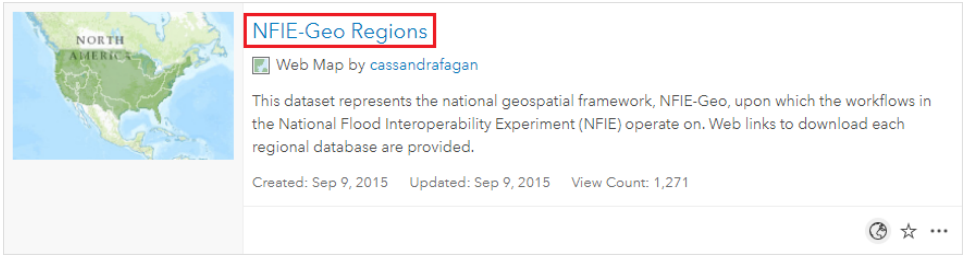
1. In a web browser, go to **www.arcgis.com** .
2. In the search box in the top right of the website, type "NFIE-Geo Regions".

If no items are returned, it is likely because you are signed in to your Rice account and the content is limited to Rice University content by default.

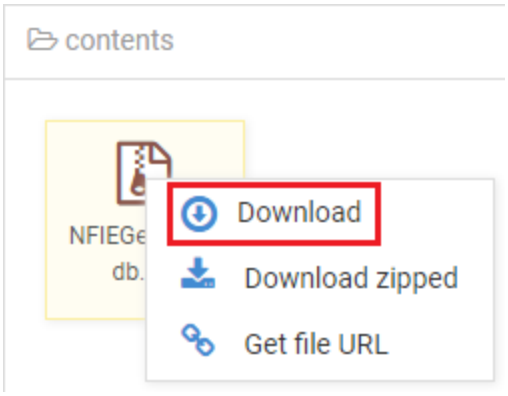
1. If necessary, in the 'Filters' section on the left sidebar, toggle off **Only search in Rice University**, at which point the proper layer should appear.



2. Click the **NFIE-Geo Regions** web map.



3. On the right, click to **Open in Map Viewer**.
4. On the map, click to select the **Texas-Gulf** region, which encompasses Houston.
5. In the table in the pop-up, next to **Hydroshare**, click **View**.
6. In the Content section, right-click the ***NFIEGeo_12.gdb.zip*** file and select **Download**.



7. Navigate to the location where the zipped file has been downloaded.
8. Right-click the downloaded ***NFIEGeo_12.gdb*** zip file and select **Extract All…**.
9. In the 'Extract Compressed (Zipped) Folders' window, click **Extract**.
10. In the new extracted folder window that opens, right-click the extracted ***NFIEGeo_12.gdb*** folder and select and **Copy**.
11. Navigate back to your ***HydrologyLab*** folder.
12. Paste the ***NFIEGeo_12.gdb*** folder directly inside your *HydrologyLab* folder. Do NOT paste them inside the *HydrologyLab.gdb* geodatabase.
13. Ensure that your *HydrologyLab* folder appears as shown below.

Name	Date modified	Type	Size
.backups	1/25/2024 4:29 PM	File folder	
GpMessages	1/25/2024 4:29 PM	File folder	
HydrologyLab.gdb	1/25/2024 4:25 PM	File folder	
HydrologyLab_index	1/25/2024 4:25 PM	File folder	
ImportLog	1/25/2024 4:24 PM	File folder	
NFIEGeo_12.gdb	1/25/2024 4:32 PM	File folder	
HydrologyLab	1/25/2024 4:24 PM	ArcGIS Project File	7 KB
HydrologyLab.atbx	1/25/2024 4:24 PM	ATBX File	1 KB

14. Return to **ArcGIS Pro**.

Adding feature data in ArcGIS Pro

Unfortunately, any changes you make to files outside of ArcGIS Pro are not automatically reflected inside ArcGIS Pro. Since you just added new files to your *HydrologyLab* folder, you may need to refresh your *HydrologyLab* folder in order for them to appear.

1. In the Catalog pane on the right of the map view, expand **Folders**, right-click your ***HydrologyLab*** folder, and select **Refresh**.
2. Expand the ***HydrologyLab*** folder > ***NFIEGeo_12.gdb*** geodatabase > ***Geographic*** feature dataset to preview what feature classes, or layers, it contains.
3. Drag the ***Geographic*** feature dataset from the Catalog pane into the *Lab1Hydrology* map view.

If you ever close the Catalog pane, you can reopen it by clicking the View tab on the ribbon and then clicking the Catalog Pane button.

The polygons in the *Subwatershed* layer represent all of the subwatersheds within the Texas-Gulf Coast Region 12, which you selected when initially downloading the data from the ArcGIS Online website. Now you will examine the attributes of this subwatershed data.

1. In the Contents pane, right-click the ***Subwatershed*** layer and select **Attribute Table**. Expand the size of the table, if desired.

You will notice three of the columns are labeled *HUC_8*, *HUC_10*, and *HUC_12*, which correspond to the subbasin, watershed, and subwatershed codes respectively. HUC stands for hydrologic unit code, which is a unique identification number assigned to each hydrologic unit in the United States. Further to the right, you will see additional columns containing the actual names of the HUC-10 watersheds and HUC-12 subwatersheds.

1. Close the *Subwatershed* **attribute table**.

Adding an online basemap

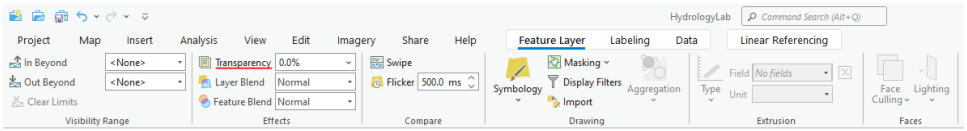
First, you would like to identify the subwatersheds within the greater Houston region, but, without any additional reference layers regarding streets or administrative boundaries, this would be very difficult to do. Fortunately, you can utilize various basemaps of the world hosted online by Esri, rather than having to obtain all of the GIS reference layers yourself. Because these basemaps are being hosted online, they cannot be edited and can sometimes be slow to load.

Though the Topographic basemap has already been added to your map by default, it appears in the background and is visually obscured by the other data layers.

1. In the Contents pane, uncheck the ***StreamGage***, ***Flowline***, ***Catchment*** and ***Waterbody*** layers, leaving only the *Subwatershed* layer visible.

The basemap is still not visible beneath the *Subwatersheds* layer, so you will need to make that layer transparent.

1. In the Contents pane, click the ***Subwatershed*** layer to select it.
2. On the ribbon, click the Feature Layer tab.
3. In the Effects group, type "**60**" to change the transparency of the layer.



Now the basemap should be visible beneath the subwatersheds.

Identifying features

Ultimately, you want to select all of the subwatersheds that lie within the Buffalo-San Jacinto subbasin in which Houston is located, but first you will need to look up the HUC-8 code corresponding to this subbasin.

1. On the ribbon, click the **Map** tab and ensure that the **Explore** tool is selected.
2. Use the navigation tools to zoom in to the **Houston** region.
3. In the map view, click near the center of Houston.

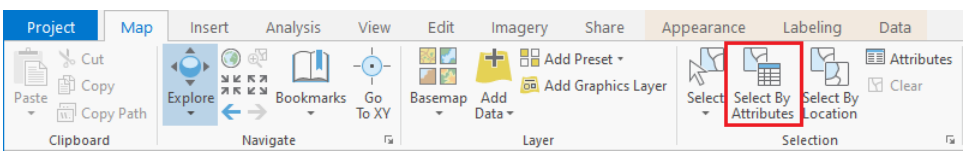
In the 'Pop-up' window, notice that the *HUC_8* field contains the code 12040104, which corresponds to the Buffalo Bayou-San Jacinto subbasin. The first two digits (**12**) stand for the region (Texas-Gulf Region). The next two digits (12**04**) stand for the subregion (Galveston Bay-San Jacinto). The next two digits (1204**01**) stand for the basin (San Jacinto). The last two digits (120401**04**) stand for the subbasin (Buffalo-San Jacinto). The additional two digits added to create the HUC-10 and HUC-12 codes stand for the watershed and subwatershed, respectively.

1. Close the '**Pop-up**' window.

Performing an attribute query

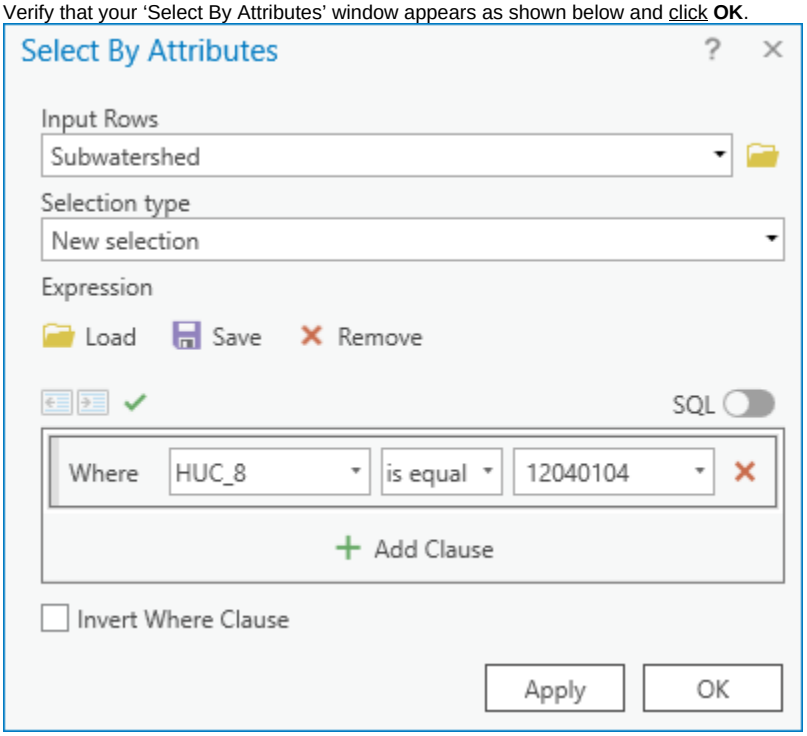
Now you are ready to perform an attribute query to select all of the subwatersheds within the Buffalo-San Jacinto subbasin (HUC-8 = 12040104).

1. On the Map tab, click the **Select by Attributes** button.

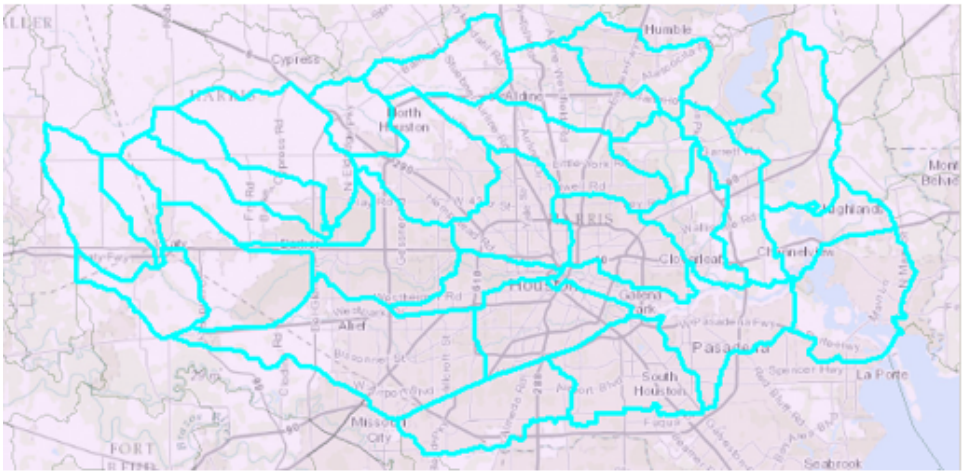


2. In the 'Select By Attributes' window, use the 'Input Rows' drop-down menu to select the ***Subwatershed*** layer, if necessary.
3. Use the 'Selection Type' drop-down menu to select **New selection**.
4. Click **New expression**.
5. For the first two fields, select ***HUC-8*** , and ***is equal to*** .
6. Type "**12040104**" in the last field.

7. Verify that your 'Select By Attributes' window appears as shown below and click **OK**.



8. In the Contents pane, right-click the ***Subwatershed*** layer and select **Selection** > **Zoom To Selection**.



Exporting selected features

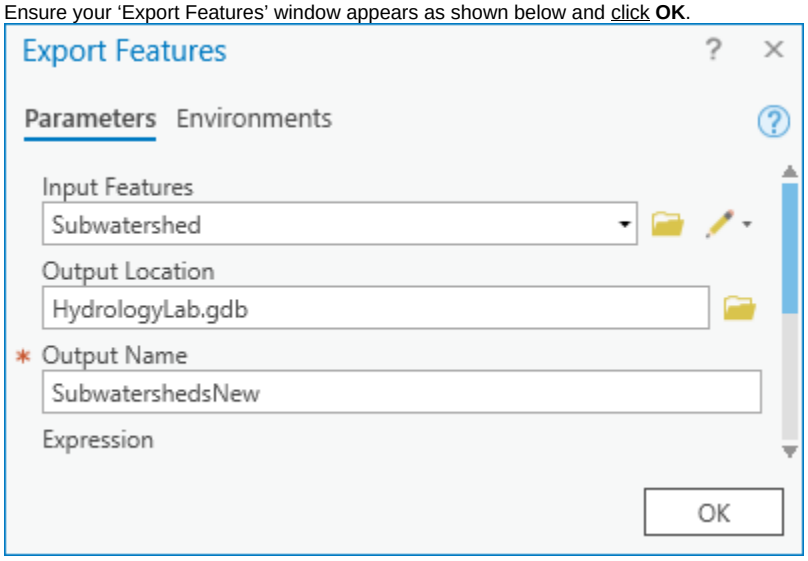
Now that the Buffalo-San Jacinto subwatersheds have been selected, they can be exported into a separate layer stored in your *HydrologyLab* geodatabase.

1. In the Contents pane, right-click the ***Subwatershed*** layer and select **Data** > **Export Features**.

By default, the 'Export Features' window will only export the selected features using the coordinate system of the data source. Also notice that the output location defaults to the *HydrologyLab* geodatabase, because that is your default geodatabase for this project.

1. For 'Output Name', type " ***SubwatershedsNew*** ".

2. Ensure your 'Export Features' window appears as shown below and click **OK**.



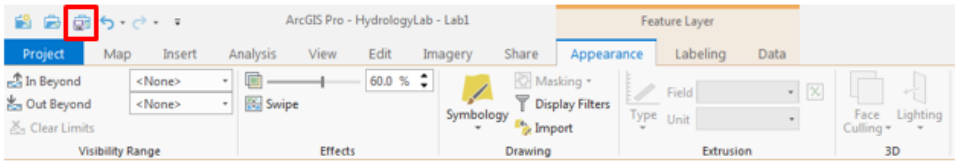
Since you've exported the particular subwatersheds of interest, you may now remove the master *Subwatersheds* layer from your map.

1. In the Contents pane, right-click the ***Subwatershed*** layer and select **Remove**.

Saving ArcGIS projects

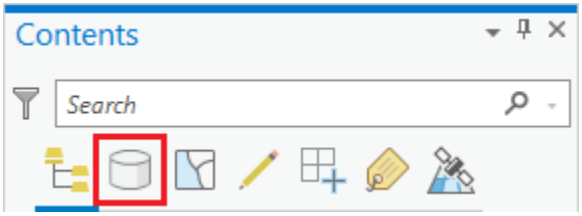
At this point, it is a good idea to save your map document and to continue saving regularly.

1. On the Quick Access toolbar, click the **Save** button.



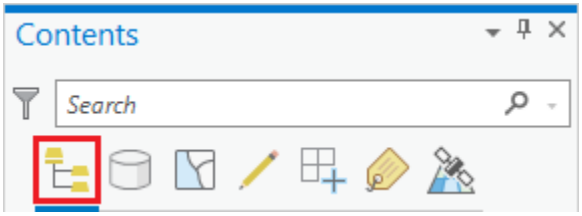
At the top of the Contents pane window, notice that the leftmost List By Drawing Order button is currently selected.

1. At the top of the Contents pane, click the **List By Source** button.



The Data Source tab displays the full file path locations of all the data layers referenced in your map. Notice that the majority of layers are still stored in the originally downloaded *NFIEGeo_12* geodatabase, but the *SubwatershedsNew* layer you just exported is now stored in your *HydrologyLab* project geodatabase.

1. At the top of the Contents pane, click the **List By Drawing Order** button to return to the list of data layers.



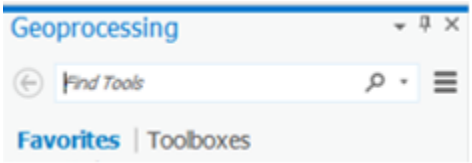
Geoprocessing: Dissolving features

Now you would like to highlight the boundary of the entire Buffalo-San Jacinto subbasin, but, if you tried to change the outline of the current *Subwatersheds* layer, it would change the outline around all subwatersheds. Instead, you will dissolve all the subwatersheds into a single subbasin feature stored in a new feature class inside your *HydrologyLab* geodatabase.

1. On the ribbon, click the **Analysis** tab and click the **Tools** button, which will open the Geoprocessing pane on the right.

Notice that at the bottom of the Geoprocessing pane, you now see the Catalog and Geoprocessing tabs. Any future panes that are opened will create additional tabs at the bottom.

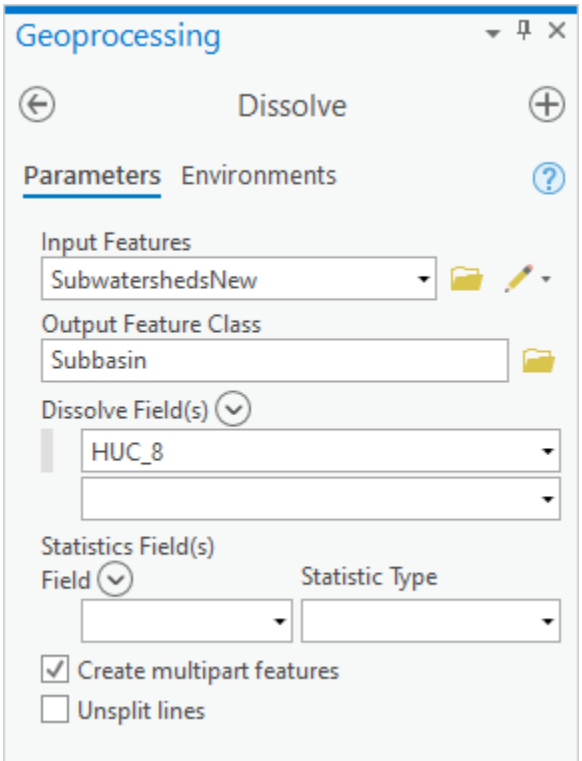
1. At the top of the Geoprocessing pane, in the 'Find Tools' box, type "**dissolve**" and press **Enter**.



2. Click **Dissolve (Data Management Tools)**.
3. In the top right corner of the 'Dissolve' tool pane, hover over the **question mark** icon.

Read the 'Dissolve' window help and review the sample illustration. Notice that this tool dissolves boundaries based on common values in a particular field. In this case, you will dissolve the subwatersheds based on their common subbasin value, resulting in a file showing only the larger subbasin boundary. If you were to click on the question mark icon, it would open up the full Dissolve tool documentation on the ArcGIS Pro help website.

1. For 'Input Features', drag in the ***SubwatershedsNew*** layer from the Contents pane or select the ***SubwatershedsNew*** option from the drop down box.
2. For 'Output Feature Class', rename the feature class from "*SubwatershedsNew_Dissolve*" to " ***Subbasin*** ".
3. For 'Dissolve_Field(s)', select the ***HUC_8*** field, since this is the field containing the common subbasin value you wish to dissolve on.
4. Ensure your 'Dissolve' tool appears as shown below, and click **Run**.



5. In the Contents pane, toggle the new ***Subbasin*** layer off and on to get a better idea of the result of the Dissolve tool.
6. In the Contents pane, right-click the ***Subbasin*** layer and select **Attribute Table**.

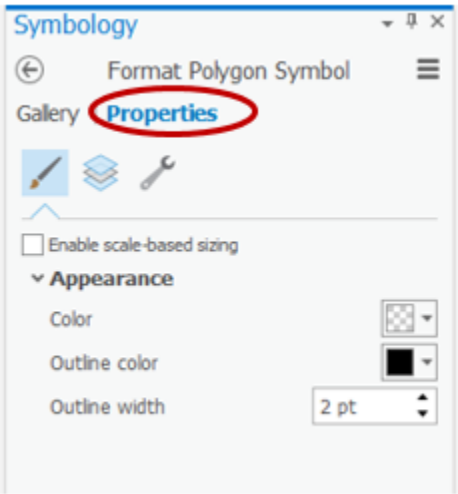
Notice that only the dissolve field, in this case the *HUC_8* field, was preserved. Because multiple subwatersheds were dissolved into a single subbasin, it is not possible to retain all of the attributes of each separate subwatershed.

1. Close the ***Subbasin* attribute table**.

In order to see all the layers simultaneously, you will give the subbasin boundary a hollow outline.

1. In the Contents pane, click the rectangle symbol beneath the *Subbasin* layer name to open the Symbology pane on the right.

2. Near the top of the Symbology pane, click the **Properties** tab.



1. For 'Color:', use the drop-down menu to select **No Color**.
2. For 'Outline Color:', used the drop-down menu to select **Black**.
3. For 'Outline Width:', type "**2**".
4. Click **Apply**.

Now you would like to create a new layer based on the watersheds in the Buffalo-San Jacinto subbasin. In order to facilitate symbolization and labeling of the watershed names, you will now dissolve the subwatersheds into their respective watershed boundaries using the HUC-10 code.

1. At the bottom of the Symbology pane, click the **Geoprocessing** tab.
2. For 'Input Features', leave the ***SubwatershedsNew*** layer previously entered.
3. For 'Output Feature Class', rename the feature class from *Subbasin* to " ***Watersheds*** ".
4. For 'Dissolve_Field(s)', select the ***HUC_10_NAME*** field.
5. Click **Run**.

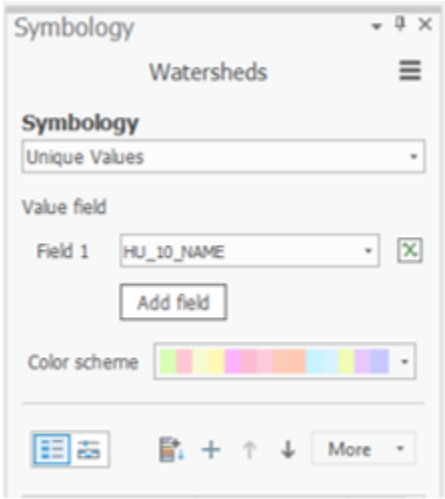
While you could have also dissolved using the *HU_10* field, the watershed name is probably more meaningful to you than the HU_10 code. You no longer need the *SubwatershedsNew* layer for this section. The rest of the analysis will be done with the new *Watersheds* layer.

1. In the Contents pane, uncheck the original ***SubwatershedsNew*** layer.
2. In the Contents pane, drag the ***Subbasin*** layer above the Watersheds layer, so it is fully visible again.

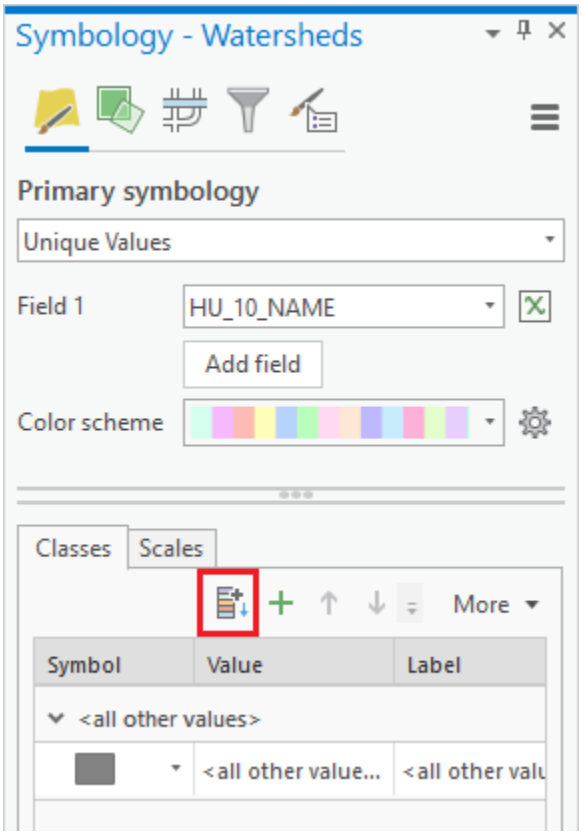
Symbolizing features by categories using unique values

Now that you have generated the watershed features within the Buffalo-San Jacinto subbasin, you will symbolize them based on their HUC-10 watershed name.

1. In the Contents pane, right-click the ***Watersheds*** layer and select **Symbology**.
2. In the Symbology pane, use the 'Primary symbology' drop-down menu to select **Unique Values**.
3. Use the 'Field 1' drop-down menu to select the ***HU_10_NAME*** field.
4. Use the 'Color Scheme' drop-down menu to select the **color ramp of your choice**.

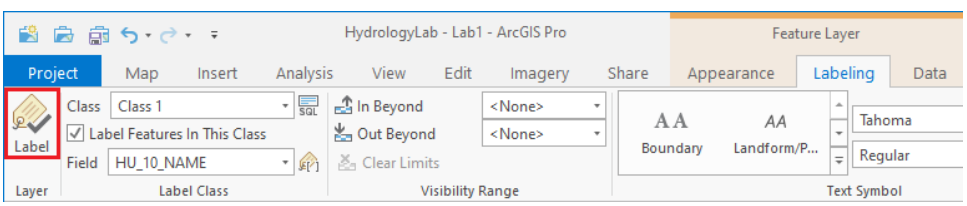


5. On the bottom half of the Symbology pane, if only one category called <all other values> is listed, as shown below, click the **Add all values** button.



Notice that the subwatersheds from the previous layer have now been grouped into 8 watersheds within the Buffalo-San Jacinto subbasin. Notice also that the transparency originally applied to the Subwatershed layer, was maintained as the layer was re-exported and then merged, such that the Topographic basemap still appears through it.

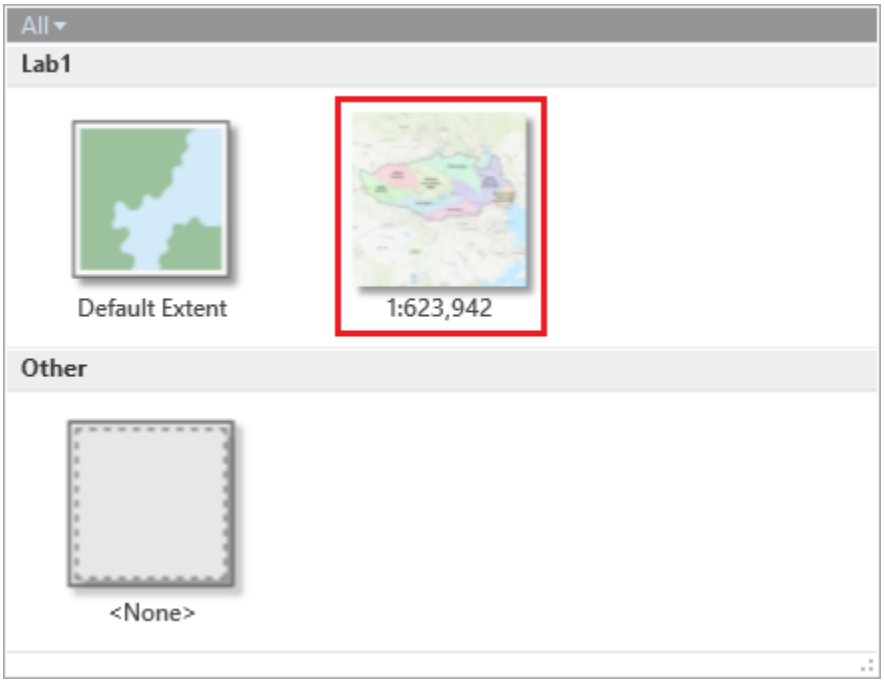
1. Ensure that the ***Watersheds*** layer is selected in Contents pane.
2. On the ribbon, click the Feature Layer contextual **Labeling** tab.
3. In the Label Class group, for 'Field', ensure the ***HU_10_NAME*** field is selected.
4. In the Layer group, click the **Enable Labeling** button to turn on the labels.



Creating a layout

1. On the ribbon, click the Insert tab.
2. In the Project group, click the **New Layout** button and, under the 'ANSI - Landscape' section, click **Letter 8.5" x 11"**.

3. On the ribbon, click the **Map Frame** group and, under the 'Lab1Hydrology' map section, select the **second frame that is labeled with the scale**, such as 1:600,000.



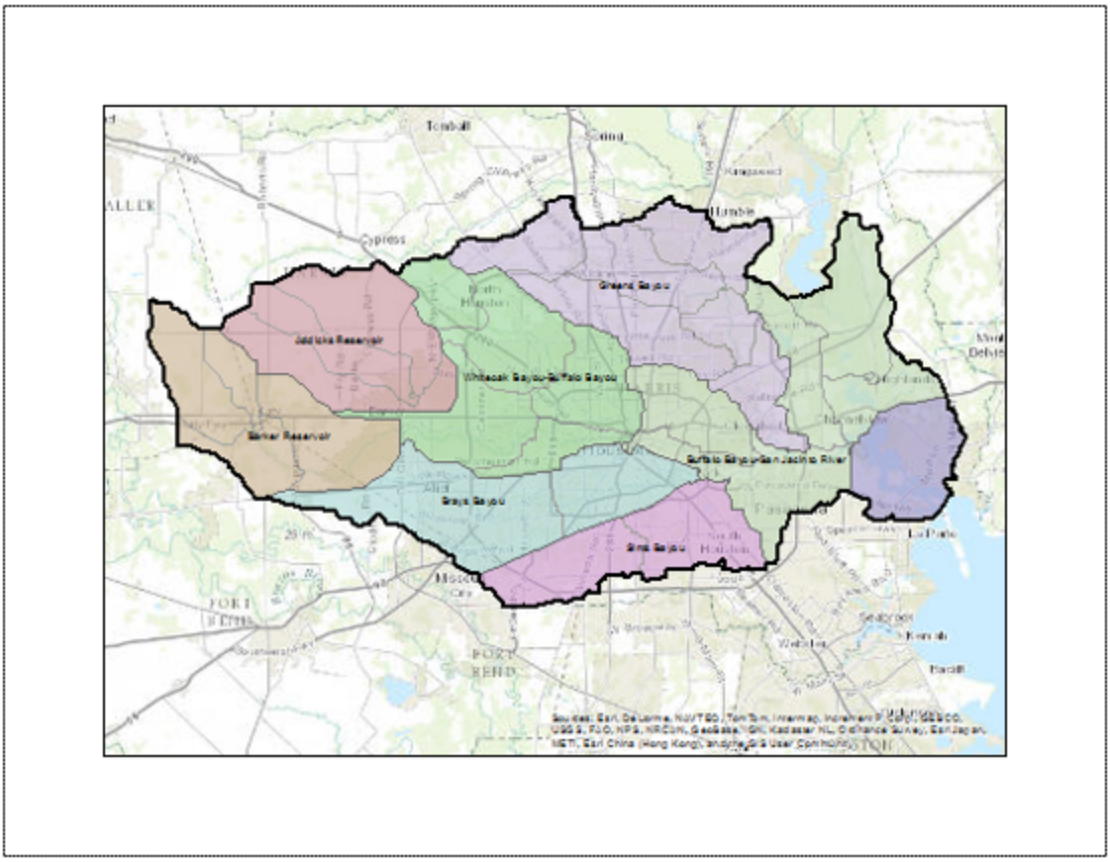
4. Under the 'Rice Bus Routes' map section, select the **second frame that is labeled with a scale**, such as 1:600:000.
5. Click and hold near the **top left corner** of the layout page and drag the rectangle near the **bottom right corner** or the layout page.
6. In the Contents pane, right-click the ***Watersheds*** layer and select **Zoom to Layer**.

Using techniques you learned last week, create a suitable map, as described for the map layout to be turned in below. All map elements, such as text, legends, north arrows, and scale bars can be added to the layout from the Insert tab on the ribbon.

1. Save your **project**

FOR MAP LAYOUT TO BE TURNED IN

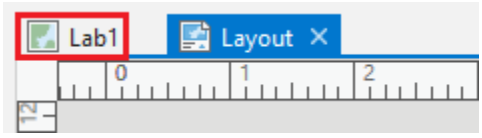
Create an 8.5" x 11" layout clearly delineating the subbasin and watersheds on top of a basemap, with the symbology and labels corresponding to the watersheds. You may need to further adjust the order of your layers in the Contents pane and their symbology.



Part 3: Mapping Flowline Data

Next, you will add flowlines to your map, which were previously downloaded from NFIE.

1. At the top left of your Layout view, click the **Lab1Hydrology** map tab to return to your map view.



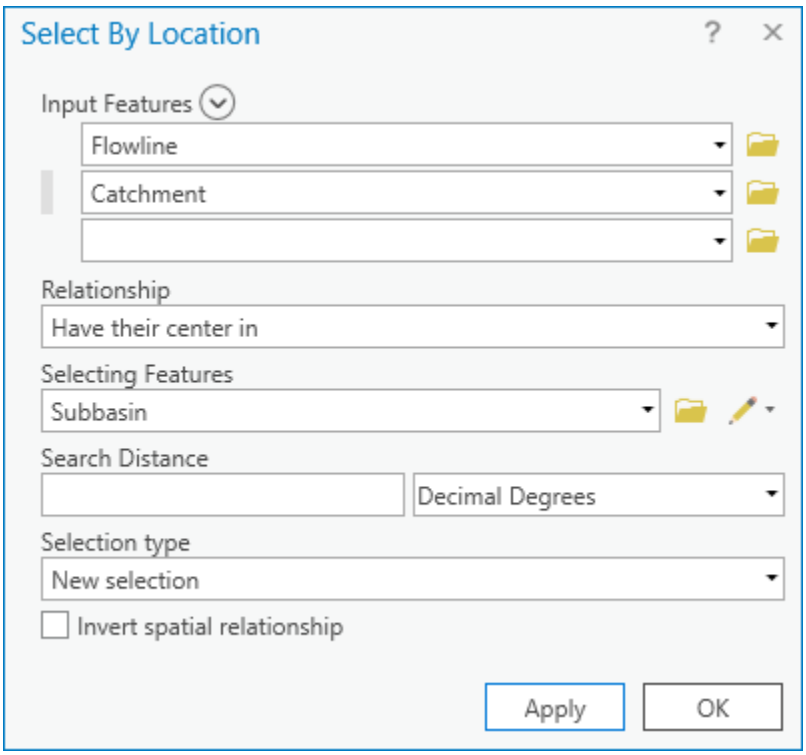
2. In the Contents pane, check the ***Flowline*** and ***Catchment*** layers to make them visible.

Performing a spatial query

Now you would like to select only the flowlines and catchments within the Buffalo-San Jacinto subbasin, but this is not possible with an attribute query, so you will instead use a spatial query.

1. On the ribbon, click the **Map** tab.
2. In the Selection group, click the **Select By Location** button.
3. For 'Input Features', use the drop-down menu to select the ***Flowline*** layer.
4. Use the second 'Input Features' drop-down menu to select the ***Catchment*** layer.
5. For 'Relationship', use the drop-down menu to select **Have their center in**. (This setting ensures that catchments and flowlines which share the outside border with the subbasin will not also get selected.)
6. For 'Selecting Features', use the drop-down menu to select the ***Subbasin*** layer.

7. Ensure your 'Select by Location' window appears as shown below and click **OK**.



All of the flowlines and catchment areas that are within the subbasin are now selected.

1. Export the selected ***Flowline*** features into your *HydrologyLab* geodatabase and name the new feature class " ***Flowlines*** ".
2. Remove the original ***Flowline*** layer from the Contents pane.
3. Export the selected ***Catchment*** features into your *HydrologyLab* geodatabase and name the new feature class " ***Catchments*** ".
4. Remove the original ***Catchment*** layer from the Contents pane.
5. Uncheck the new ***Catchments*** layer, so it is no longer visible.

Symbolizing features using a single symbol

1. In the Contents pane, click the **line symbol** beneath the *Flowlines* layer name.
2. At the top of the Symbology pane, click the **Gallery** tab and select the **Water (line)** symbol.

Calculating summary statistics for an attribute table field

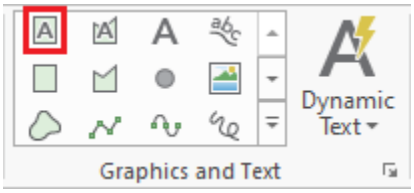
1. Open the ***Flowline s* attribute table**.
2. Scroll right to the 8th field and right-click the ***LENGTHKM*** field name and select **Statistics**.

From the Chart Properties pane on the right, you can see there are 543 flowlines in the Buffalo-San Jacinto basin whose average length is 1.94 km and total length is 1052 km.

1. View the statistics for the ***AreaSqKM*** field in the ***Catchments*** attribute table.

Based on the statistics you have just seen, calculate the answers to the questions listed for the map layout to be turned in below. In order to add the statistics to your map layout, you will insert a rectangle text element.

1. At the top left of your map view, click the **Layout** tab to return to your layout view.
2. On the ribbon, click the **Insert** tab.
3. In the Graphics and Text group, click the **Rectangle text** button.



4. Drag a **rectangle** on your map layout to insert a rectangle text element.

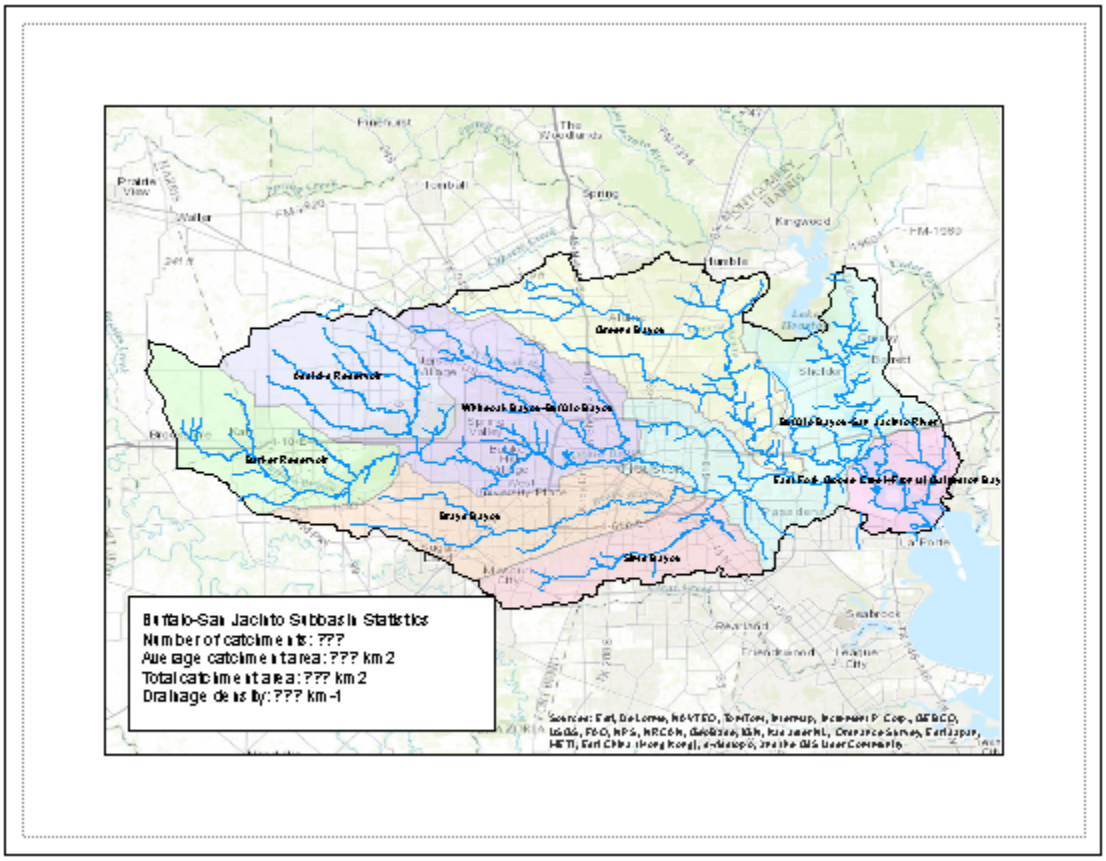
You can edit the text and customize the rectangle appearance by double-clicking on the rectangle text element and using the 'Format Text' Element pane on the right.

1. Save your **project**.

FOR MAP LAYOUT TO BE TURNED IN

Add a text box to the layout containing the answers to the following questions:

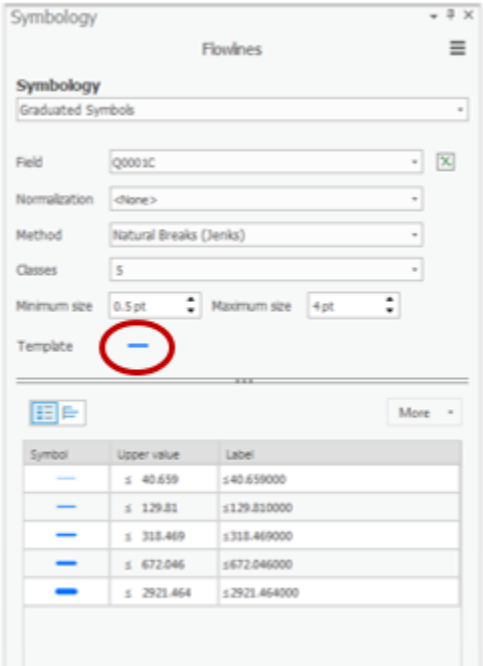
1. How many catchments are there in the Buffalo-San Jacinto subbasin?
2. What is their average area in acres and in km^2? (Look up conversion factor.)
3. What is the total area of catchments in km^2?
4. What is the ratio of the total length of the streamlines to the total area of the Buffalo-San Jacinto catchments (called the drainage density) in km^{-1}?



Symbolizing features by quantities using graduated symbols

1. Return to the **Lab1Hydrology** map view.
2. Open the *Flowlines* Symbology tab.
3. Use 'Primary Symbol' drop down menu to select **Graduated symbols**.
4. Use the 'Field' drop-down menu to select the *Q0001C* field, which contains the mean annual flow.

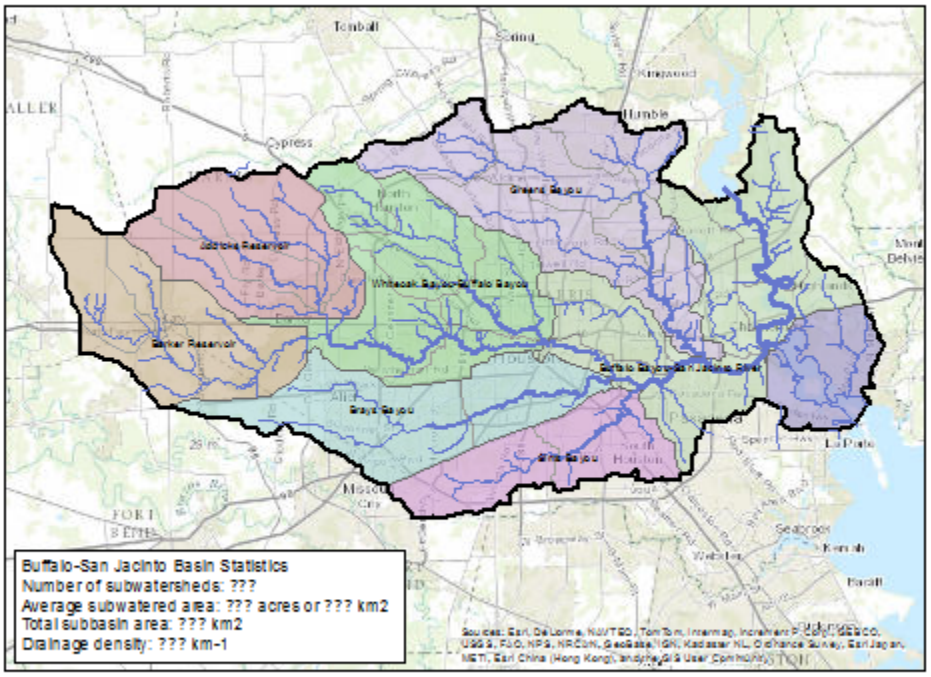
5. Click the line next to Template to change the symbology of your flowlines.



6. Save your **project**.

FOR MAP LAYOUT TO BE TURNED IN

The flowlines should have graduated symbology based on their mean annual flow.



Part 4: Mapping Stream Gauge Data

Selecting data within subbasin

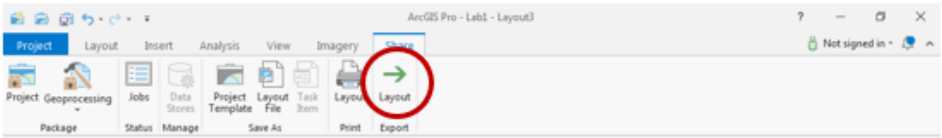
1. In the Contents pane, check the ***StreamGage*** layer which you brought in at the beginning with the *Geographic* feature dataset from the *NFIEGeo_12 Geodatabase*.
2. On the ribbon, click the **Map** tab.
3. Click the **Select By Location** button.
4. For 'Input Features', use the drop-down menu to select the ***StreamGage*** layer.
5. For 'Relationship', use the drop-down menu to select **Within**.
6. For 'Selecting Features', use the drop-down menu to select the ***Subbasin*** layer.
7. Click **OK**.

All of the stream gages that are within the subbasin are now selected.

1. Export the selected ***StreamGage*** features into your *HydrologyLab* geodatabase and name the new feature class " ***SubbasinStreamGages*** ".
2. Remove the original ***StreamGage*** layer from the Contents pane.

Export a layout

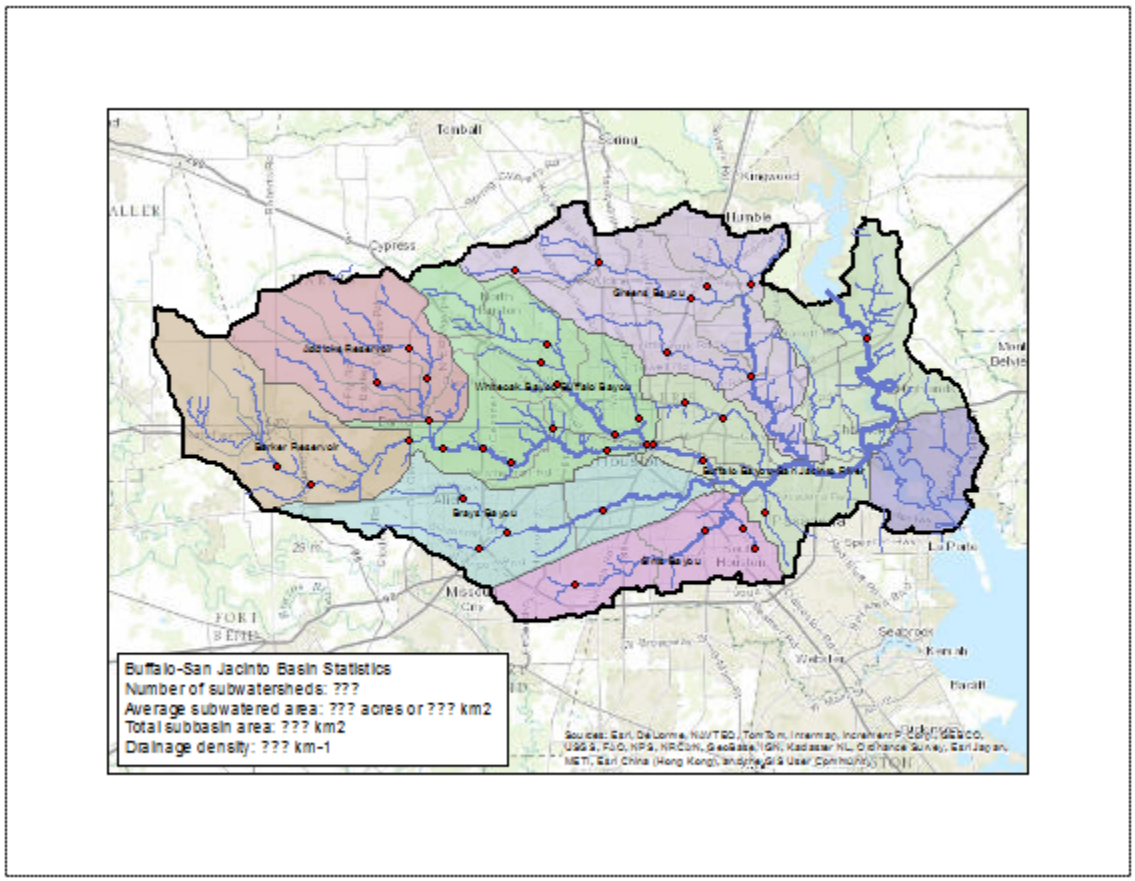
1. Return to the **Layout** view.
2. On the ribbon, click the Share tab and click the **Layout** button in the Export group to open the Export Layout pane on the right.



3. In the Export Layout pane, use the 'File Type' drop-down menu to select **PDF**.
4. For 'Name', type "**Lab 1 Hydrology**" and click **Export**.
5. Save your **project**.

FOR MAP LAYOUT TO BE TURNED IN

The stream gage site locations should be added to the map layout.

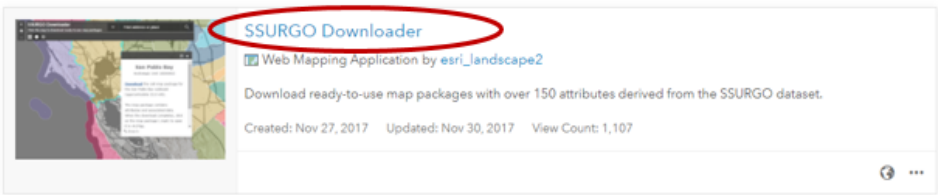


Part 5: Mapping Soils Data

Downloading SSURGO data

1. In a web browser, go to http://arcgis.com.
2. On the top right search bar, search for "**SSURGO Downloader**".
3. Again, if necessary, in the 'Filters' section on the left sidebar, toggle off **Only search in Rice University**, at which point the proper layer should appear.

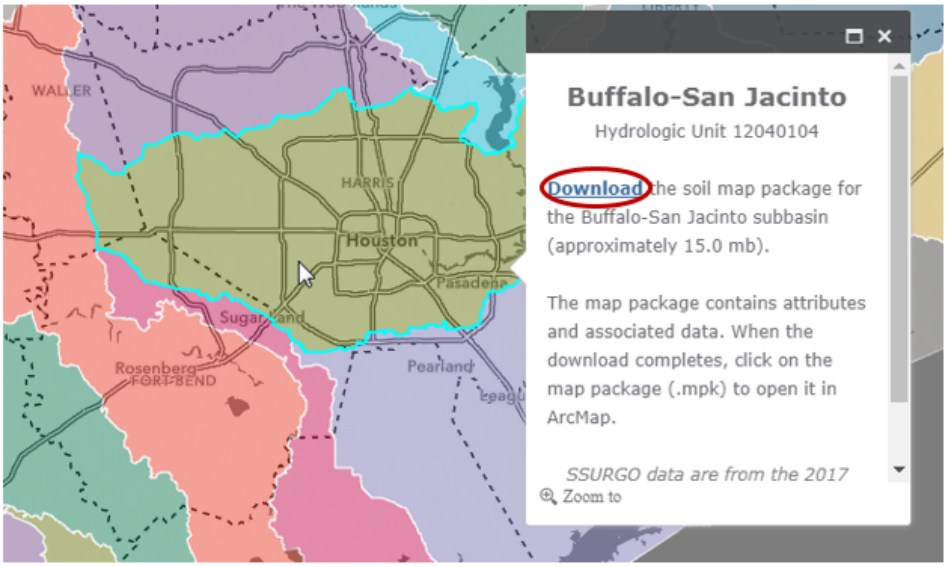
1. Click the **SSURGO Downloader** web mapping application.



2. On the right side of the webpage click the **View Application** button.

3. In the search bar in the top corner, type "**Houston, TX**".

4. Click in the Buffalo-San Jacinto subbasin to select it and click the **Download** link.



5. Right-click on your downloaded ***BuffaloSanJacinto_12040104.ppkx*** file and select **Show in folder**. Copy the **file**.
6. Navigate back to your ***HydrologyLab*** folder.

7. Paste the ***BuffaloSanJacinto_12040104.ppkx*** file directly inside your *HydrologyLab* folder. Do NOT paste it inside the *Hydrologylab.gdb* geodata base.
8. Single-click the **.ppkx file** to select it and press **Enter**.

A new ArcGIS Pro application window will open. You will complete Part 5 using this window, but do not close your previous ArcGIS Pro window.

A packaged project file (.ppkx), contains both a project (.aprx) and all data layers referenced in the project in a project geodatabase (.gdb). The new instance of ArcGIS Pro will open showing the different soil classes within the subbasin.

1. In the Contents pane, right-click the ***Subbasin*** layer and select **Zoom To Layer**.
2. On the Map tab, click the **Explore** button.
3. In the Contents pane, uncheck the ***Subbasin*** layer, so that it will not be queried in the next step.
4. In the Map view, click on **any of the soil classes**.

Scroll down through the list of fields to see the wide variety of data available for each soil class. You may need to scroll to the right to see the actual values stored in these fields. In particular, you will be utilizing the data stored in the *Available Water Storage 0-100 cm – Weighted Average* field.

Geoprocessing: Clipping features

You will now clip the soil polygons to the extent of the Buffalo-San Jacinto subbasin.

1. On the ribbon, click the **Analysis** tab and click the **Tools** button.
2. At the top of the Geoprocessing pane, in the 'Find Tools' search bar, type "**clip**" and press **Enter**.
3. Click **Clip (Analysis Tools)**.

Read the ‘Clip’ window help and review the sample illustration. Notice that this tool clips one dataset to the extent, or shape, of another dataset.

1. For ‘Input Features’, use the drop-down menu to select the ***Mapunits*** layer.
2. For ‘Clip Features’, use the drop-down menu to select the ***Subbasin*** layer.

Hover over the ‘Output Feature Class’ field and note that the file path did not default to your *HydrologyLab* geodatabase, but instead to the default geodatabase that was referenced in the map package you downloaded. You will change this to your default project geodatabase.

1. For 'Output Feature Class', click the **Browse** button.
2. Navigate to your ***HydrologyLab*** folder and double-click the ***HydrologyLab*** geodatabase.
3. For 'Name', type “ ***Soils*** ” and click **Save**.
4. In the Geoprocessing pane, again hover over the ‘Output Feature Class’ field to ensure the output *Soils* feature class will be stored in your HydrologyLab geodatabase and click **Run**.

Notice that the resulting *Soils* layer maintains the soil class boundaries, but limits the extent of the soils layer to the extent of the subbasin boundary.

You will now return to your main *HydrologyLab* project application window.

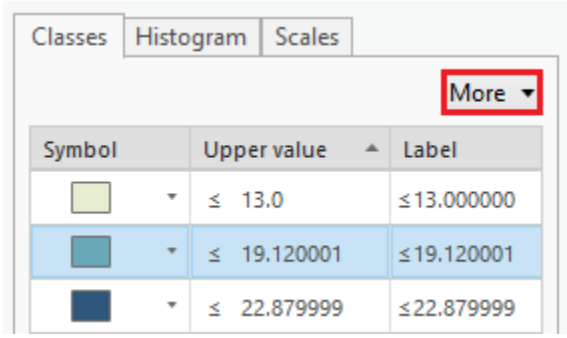
1. Close the **BuffaloSanJacinto_12040104** project in ArcGIS Pro without saving.
2. Return to your **HydrologyLab** project.
3. On the ribbon, click the **Insert** tab.
4. On the far left, click the **New Map** button.
5. In the Contents pane, click ***Map*** once to select it. Then, click directly on the ***Map*** text a second time and rename it " ***Lab1Soils*** ".
6. At the bottom of the far right pane, click the **Catalog** tab.
7. Right-click the ***HydrologyLab.gdb*** geodatabase and select **Refresh**.
8. Drag the newly clipped ***Soils*** feature class from the Catalog pane to the ***Lab1Soils*** map view.
9. Also, drag the ***Subbasin*** feature class from the Catalog pane to the ***Lab1Soils*** map view.
10. Symbolize the ***Subbasin*** layer using the same symbology as you used in the *Lab1Hydrology* map, with no color and a black outline.

Symbolizing features by quantities using graduated colors

1. In the Contents pane, click the ***Soils*** layer to select it.
2. If necessary, open the **Symbology** pane.
3. For 'Primary symbology', select **Graduated Colors**.
4. For ‘Field’, select the ***Available Water Storage 0-100 cm – Weighted Average*** field.
5. Experiment with the '**Method**', '**Classes**', and '**Color scheme**' fields.

Notice that the density of the polygon outlines obscures the colors of the polygons themselves.

1. On the bottom half of the symbology pane, click the **More** drop-down button and select **Formal all symbols**.



2. Use the 'Outline Color' drop-down menu to select **No Color**.
3. Click **Apply**.

Now you will calculate the water storage capacity of the top 1 m of soil within the Buffalo-San Jacinto subbasin.

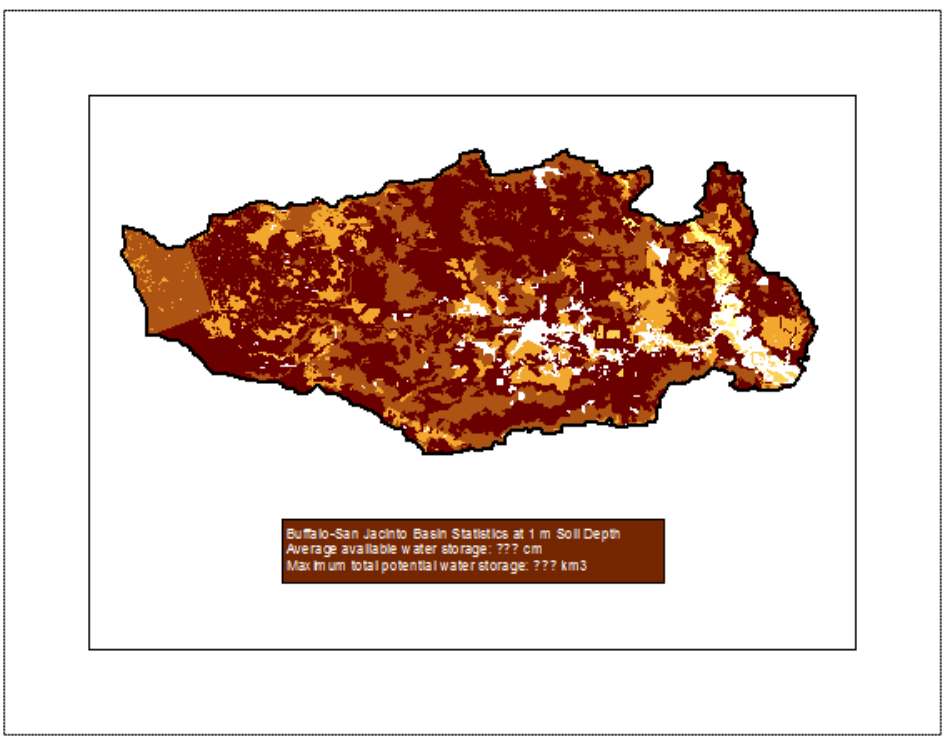
1. Open the ***Soils*** layer attribute table.
2. Calculate statistics for the *Available Water Storage 0-100 cm – Weighted Average* field.

Based on the statistics you have just seen, calculate the answers to the questions listed for the map layout to be turned in below. Note that, technically, a true calculation of the average available water storage for the subbasin would require factoring in the area of each soil polygon to calculate a weighted average. In this case, just use the statistical mean as it is listed in the 'Statistics' window. Similarly, the total water storage for the subbasin would require multiplying the available water storage by the area of each soil polygon and then summing the results. In this case, you may simply multiply the area of the entire subbasin by the statistical mean as it is listed in the 'Statistics' window.

As before, create a new map layout and add the statistics using a rectangle text element. When your layout is complete, export it as a PDF.

TO BE TURNED IN: An 8.5 x 11 map document showing the soils clipped to the Buffalo-San Jacinto subbasin and a text box containing the answers to the following questions:

1. What is the average available water storage (cm) in the Buffalo-San Jacinto subbasin?
2. Based on your previous calculation of the area of the subbasin in km^2, what volume of water (km^3) could potentially be stored in the top 1 m of soil in the Buffalo-San Jacinto subbasin if the soil were fully saturated with water?



Deliverables

1. Create an 8.5 x 11 layout with the following layers limited to the subbasin:
    - Subbasin – hollow outline
    - Watersheds – categorical symbology and labeled
    - Flowlines – graduated symbology

- Stream gages – point symbol
- Basemap

Include a text box in the layout containing the answers to the following questions:

1. How many HUC-12 catchments are there in the Buffalo-San Jacinto Basin?
2. What is their average area in km^2?
3. What is the total area of this subbasin in km^2?
4. What is the ratio of the length of the streamlines to the area of the Buffalo-San Jacinto subbasin (called the drainage density) in km^{-1}?

2. Create an 8.5 x 11 layout with the following layers limited to the subbasin:

- Subbasin – hollow outline
- Soils – graduated colors

Include a text box in the layout containing the answers to the following questions:

1. What is the average available water storage (cm) in the Buffalo-San Jacinto subbasin?
2. Based on your previous calculation of the area of the subbasin in km^2, what volume of water (km^3) could potentially be stored in the top 1 m of soil in the Buffalo-San Jacinto subbasin if the soil were fully saturated with water?