

# ESCI 545 - Hydrocarbon Systems Analysis



This guide was created by the staff of the GIS/Data Center at Rice University for the custom course - ESCI 545 Hydrocarbon Systems Analysis - 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."



Presentation Slides

[PlayMapping.zip](#)



**Course Objective:** Use GIS workflows to collate and synthesize datasets to create geologic and play elements maps that will be used in petroleum system and risk analysis of potential opportunities and plays.

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## Getting Started

For more practice navigating the ArcGIS Pro interface, check out our short course: [Introduction to ArcGIS Pro](#)

## Creating a New Project in ArcGIS Pro

1. From the Start menu, launch **ArcGIS Pro**.
2. When ArcGIS Pro opens, under the New Blank Template section, click the **Map** project template.
3. In the 'Create a New Project' window, for Name, type "**PlayMapping**".
4. For Location, click the **Browse...** button to the right.
5. In the 'Select a folder to store the project.' window, click **Computer** in the left column and click **Desktop** in the right column and click **OK**.
6. In the 'Create a New Project' Window, click **OK**.
7. Maximize the **ArcGIS Pro** application window.

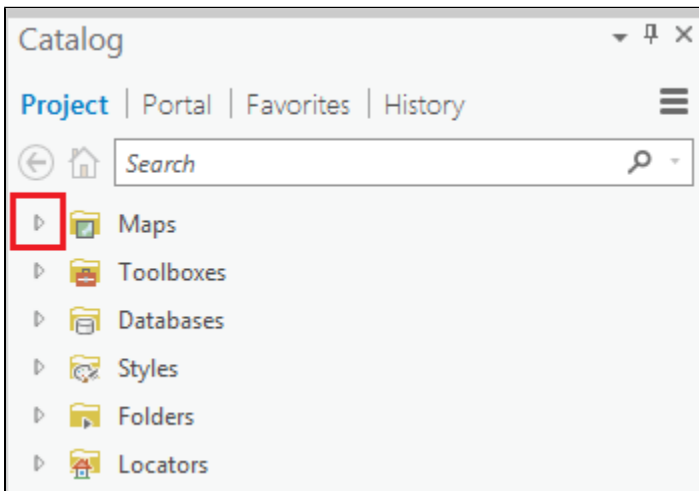
## Editing the New Map

A map is a project item used to display and work with geographic data in two dimensions. The first step to visualizing any data is creating a new map. The Ribbon runs horizontally across the top of the ArcGIS Pro interface. Tools (buttons) are organized into tabs along the Ribbon.

You will notice that a new Map View opens in the main section of ArcGIS Pro. The panel on the left side of ArcGIS Pro is called the Contents pane. The Contents pane displays the default *Map* title and automatically adds the *Topographic* basemap layer to the map.

The panel on the right side of ArcGIS Pro is called the Catalog pane. The Maps section is at the top of the Project tab within the Catalog pane.

1. In the Catalog pane, click the arrow to expand the **Maps** section.



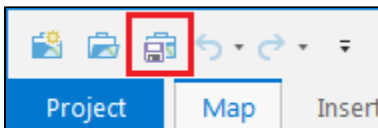
Notice that there is a single map there, named *Map*. Since most projects will have multiple maps, it is a good idea to name your maps with more descriptive titles.

2. In the Catalog pane, under the Maps section, right-click **Map** and select **Rename**.
3. Type "**GISWorkshop**" and hit **Enter**.

## Saving a Project

Any time you create a new project item (such as a map or a layout), spend time adjusting the symbology of your map layers, or are preparing to run a tool, it is a good idea to save your project.

1. Above the Ribbon, on the Quick Access toolbar, click the **Save** button.



## Data Management

For more practice with Data Management, check out our short course: [Introduction to GIS Data Management](#)

## Download Workshop Data

### Workshop Data Download

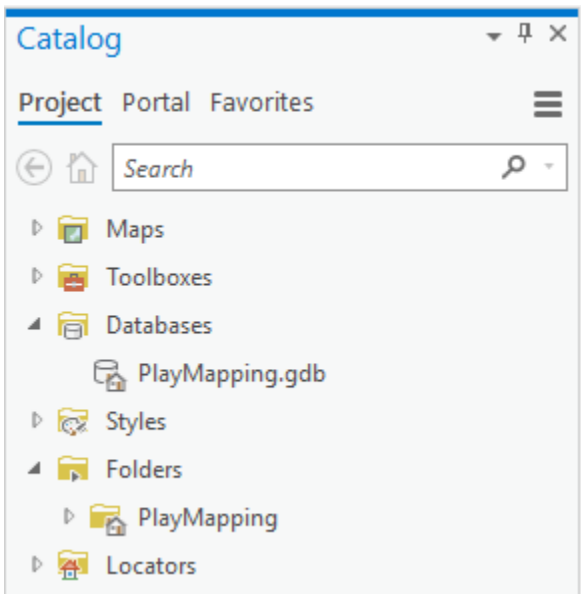
- [Workshop\\_Data.zip](#)

1. Click **Workshop\_Data.zip** above to download the tutorial data. Make a note where this file is saved on your personal computer.
2. Open your **Downloads** folder.
3. Right-click **Workshop\_Data.zip** and select **Extract All...**
4. In the Extract Compressed (Zipped) Folders window, accept the **default location** into the *Downloads* folder.
5. Click **Extract**.

## Browsing Existing Data

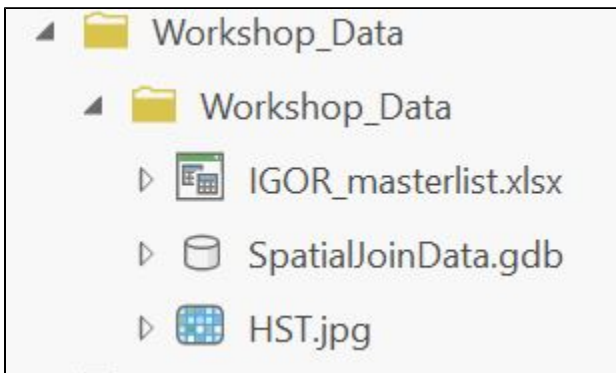
1. In the Catalog pane, click the arrow to expand the **Databases** section.

2. Click the arrow to expand the **PlayMapping.gdb** geodatabase. You will notice there is no data in the project geodatabase. Over the next few sections, we will transfer and generate data to this project geodatabase.
3. In the Catalog pane, click the arrow to expand the **Folders** section. Again, notice there is no data in the folder, just the default PlayMapping folder created with this project.



## Connecting to a Folder

1. In the Catalog pane, right-click Folders and select Add Folder Connection.
2. Navigate to your personal downloads folder and click on **Downloads**.
3. Click OK.
4. In the Catalog pane, expand Downloads and then expand the **Workshop\_Data** folder.
5. Your **Workshop\_Data** folder should look like the below image.

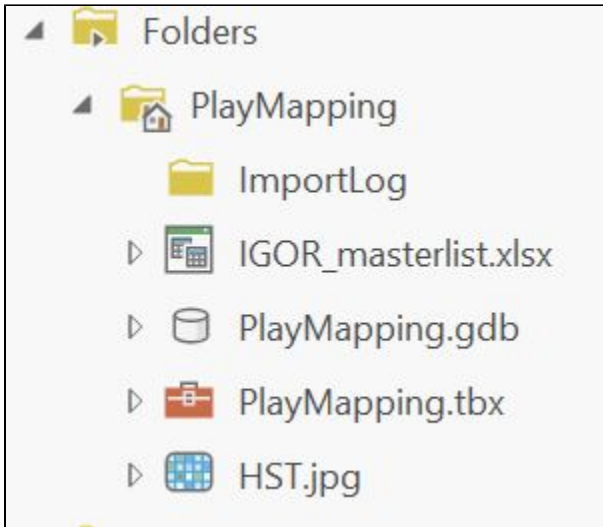


6. Expand the **SpatialJoinData.gdb** so you can see the **geologic\_features\_poly** feature class.

## Importing Data to Project Geodatabase and Project Folder

1. In the Catalog pane, click-and-hold the **geologic\_features\_poly** geodatabase feature class from the **SpatialJoinData.gdb** and drag-and-drop it up into the **PlayMapping.gdb**. A progress bar will appear that reads 'Copying...'. Once it is complete, you will see a copy of **geologic\_features\_poly** inside the **PlayMapping.gdb**.
2. In the Catalog pane, click-and-hold the **HST.jpg** from the **Workshop\_Data** folder and drag-and-drop it up into the **PlayMapping project folder**.
3. In the Catalog pane, click-and-hold the **IGOR\_masterlist excel file** from the **Workshop\_Data** folder and drag-and-drop it up into the **PlayMapping project folder**.
4. In the Catalog pane, in the Folders section, right-click on **Downloads** and select Remove.

5. Your PlayMapping project folder should look like the below image.



## Adding Data to a Map

For more practice with Coordinate Systems, check out our short course: [Introduction to Coordinate Systems and Projections](#)

1. The map takes on the projection of the first data layer added. If a JPG is added first, then the map projection would be undefined (as the projection for a JPG is undefined). To define the map's coordinate system, in the Contents pane on the left, right-click the **GISWorkshop** map and navigate to **Properties > Coordinate Systems > Geographic Coordinate Systems > North America > USA and Territories > NAD 1927**.
2. Click **OK** in the Properties window.
3. In the Catalog pane, right-click the **HST.jpg** raster and select **Add To Current Map**.
4. An alternative method of adding data to a map is to click-and-hold the item and drag-and-drop it into the Map View.

## Georeferencing

Georeferencing is the process of defining the location of raster data using map coordinates which allows it to be viewed, queried, and analyzed with your other geographic data. For more practice with Georeferencing, check out our short course: [Mapping Imagery](#). For more information on Georeferencing in ArcGIS Pro, check out this help resource: [Georeferencing](#)

When Georeferencing, as well as later editing we will do in this course, click and hold the **mouse scroll wheel** to pan across the screen when you are currently in an editing session.

1. In the Contents pane, right-click **HST.jpg** then click **Zoom to Layer**.
2. In the Contents pane, click **HST.jpg** so that it is highlighted in light blue. From the Ribbon, click the **Imagery** tab and then click the **Georeference** button.

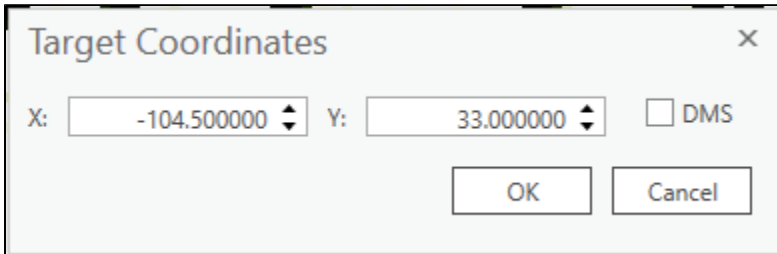


3. Click **Add Control Points**.



4. Left-click the **top left corner** of the HST JPG. This selects this point on the JPG to georeference. If you need to zoom in and pan around to see the corners of the JPG, you can move the mouse scroll wheel to zoom and click and drag the mouse scroll wheel to pan.
5. Right-click anywhere on the map. This opens up a **Target Coordinates** pop-up box, in which you can manually enter X and Y values.

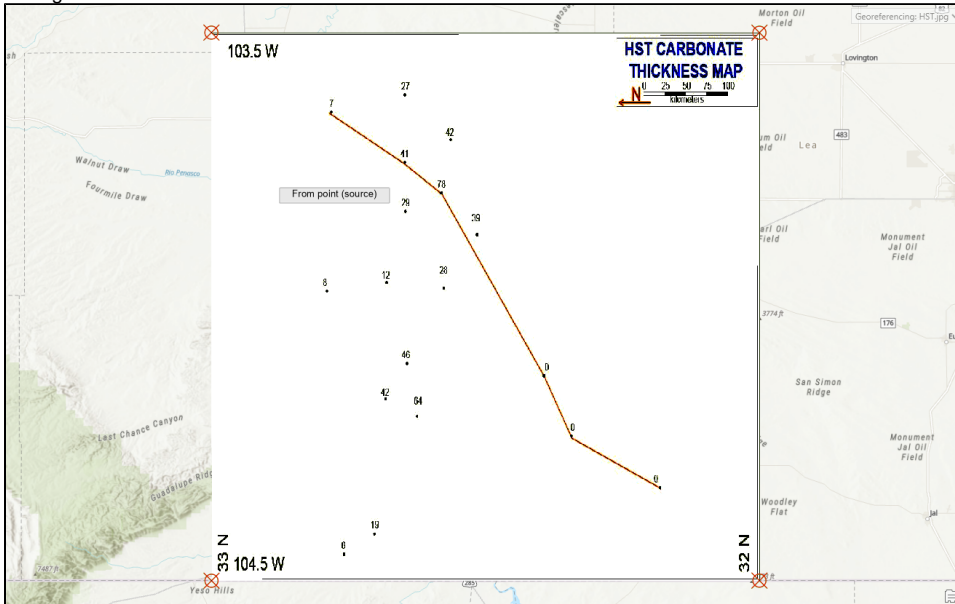
6. Type **X : -104.5**, **Y : 33** and click **OK**. The x-value is the West coordinate and it is negative because we are in the Western Hemisphere. The y-value is the North coordinate.



A dialog box titled "Target Coordinates" with a close button (X) in the top right corner. It contains two input fields: "X:" with the value "-104.500000" and "Y:" with the value "33.000000". There is a checkbox labeled "DMS" which is currently unchecked. At the bottom are two buttons: "OK" and "Cancel".

7. In the Contents pane, right-click **HST** and click **Zoom to Layer**.
8. Repeat steps 5-8 for the bottom right corner of HST, but type **X : -103.5**, **Y : 32**.
9. Repeat steps 5-8 for the bottom left corner of HST but type **X : -104.5**, **Y : 32**.
10. Repeat steps 5-8 for the top right corner but type **X : -103.5**, **Y : 33**.

Your georeferenced HST should look like this:



11. From the Georeferencing tab, click **Save**.



12. Then click **Close Georeference**.



13. Above the Ribbon, on the Quick Access toolbar, click the **Save** button.

## Digitizing Features

For more practice with Digitizing Features, check out our short course: [Creating Vector Data](#). For more information on digitizing features in ArcGIS Pro, check out this help resource: [Creating Features](#)

1. In the Catalog pane, expand the **Databases** section.
2. Right-click **PlayMapping.gdb** and select **New > Feature Class**.
3. Name it "HSTPoints".

4. Under the Feature Class Type drop-down box, select **Point**.

**Create Feature Class**

**Define**

Name:

Alias:

**Feature Class Type**

Type of features stored in the feature class.

**Geometric Properties**

☐ M Values - Coordinates include M values used to store route data.

☒ Z Values - Coordinates include Z values used to store 3D data.

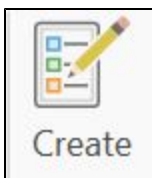
5. Click **Next** twice.
6. In the Spatial Reference section, under the Layers section, select the NAD 1927 projection.
7. Click **Next** twice again.
8. Click **Finish**.
9. If the new feature class did not automatically add to your map: From the Catalog pane in the Databases section, expand **PlayMapping.gdb**. Right-click **HSTPoints** and select **Add to Current Map**.
10. In the Contents pane, right-click **HSTPoints** and select **Attribute Table**.
11. From the top of the attribute table, next to the **Field:** section, click the **Add** button.



12. A new Fields view table appears. In the third row of the Field Name column, type "Thickness".
13. Change the Data Type to Short Integer by clicking the drop-down box then selecting **Short**.

<input checked="" type="checkbox"/> Visible	<input checked="" type="checkbox"/> Read Only	Field Name	Alias	Data Type
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	OBJECTID	OBJECTID	Object ID
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Shape	Shape	Geometry
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Thickness		<input type="text" value="Short"/>

14. From the Ribbon, in the Fields tab, click the **Save** button.
15. Close the Fields view table by clicking the **X** at the top right corner of **Fields: HSTPoints**.
16. From the Ribbon, select the **Edit** tab.
17. From the Edit tab, in the Features group, click **Create**. A new pane, Create Features, opens on the right side of the screen.



18. From the Create Features pane, click **HSTPoints** and select the **Point** button (first in list).

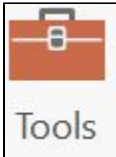


19. In the Map View, click to **add a point** on the topmost left point displayed on the *HST.jpg*.
20. In the Attribute Table, a new row has been generated for this newly created point. Click in the **Thickness** cell for this row and type "7".
21. Repeat steps 19 and 20 for all points on *HST.jpg*.
22. From the Edit tab, in the Manage Edits group, click **Save**.
23. Click **Yes** for the 'Save all edits?' pop-up window.
24. In the Edit tab, navigate to the **Selection** section and click the **Clear** button to unselect any points.
25. Close the **Create Features** pane.
26. Close the **Attribute Table**.
27. Above the Ribbon, on the Quick Access toolbar, click the **Save** button.

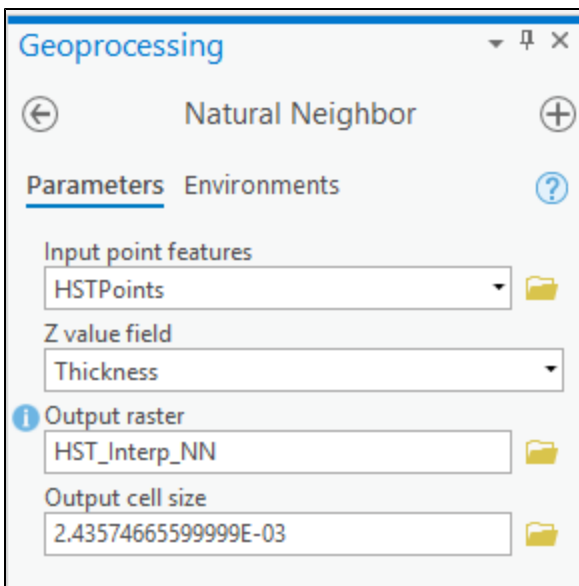
## Interpolation

This section steps through how to interpolate a raster surface from points using a natural neighbor technique. For more practice with Interpolation, check out our short course: [Data Interpolation and Extraction](#). For more information on Natural Neighbor Interpolation in ArcGIS Pro, check out this tool reference: [Natural Neighbor \(Spatial Analyst\)](#)

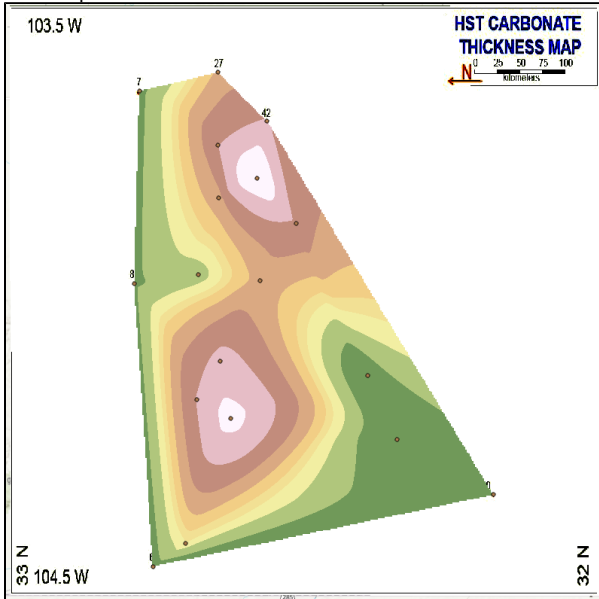
1. From the Ribbon, click the **Analysis** tab.
2. From the Analysis tab, in the Geoprocessing group, click the **Tools** button. A new pane, Geoprocessing, will appear on the right side of the screen.



3. In the Geoprocessing pane, type "**Natural Neighbor**" into the 'Find Tools' search bar.
4. Select **Natural Neighbor (Spatial Analyst Tools)**.
5. Under Input point features, click the drop-down menu and select **HSTPoints**.
6. Under Z value field, choose **Thickness**.
7. Under Output raster, change the name to **HST\_Interp\_NN**.
8. When your Geoprocessing pane looks like this, click **Run**.



Your output raster should look like this:



9. Above the Ribbon, on the Quick Access toolbar, click the **Save** button.

## Symbology

For more practice with Symbology, check out our short course: [Introduction to ArcGIS Pro](#). For more information on Symbology in ArcGIS Pro, check out this help resource: [Symbology](#)

1. In the Contents pane, right-click **HST\_Interp\_NN** and select **Symbology**. A new pane, Symbology, will open up on the right side of the screen. From here you can change the symbology settings, which affects how the **HST\_Interp\_NN** raster is displayed on the map. Stretched symbology displays continuous raster cell values across a gradual ramp of colors. Classified symbology displays thematic rasters by grouping cell values into classes.
2. In the Symbology pane, choose **Classify** from the Primary symbology drop down menu. To change the number or classes, use the drop-down box under Classes. To manually alter the class intervals, double-click the upper values box you would like to edit and enter the new values. To change the color, use the drop-down options under Color Scheme.
3. In the Symbology pane, choose **Stretch** from the Primary symbology drop down menu. To change the color, use the drop-down options under Color Scheme.
4. Above the Ribbon, on the Quick Access toolbar, click the **Save** button.

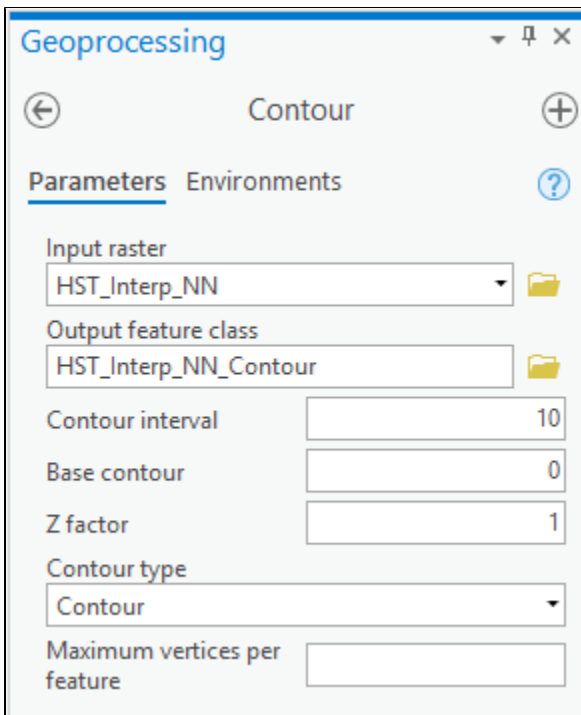
## Contour

This section steps through how to generate contour lines by joining points with the same elevation from a raster dataset. For more information on the Contour tool in ArcGIS Pro, check out this tool reference: [Contour](#)

1. From the Ribbon, click the **Analysis** tab.
2. From the Analysis tab, in the Geoprocessing group, click the **Tools** button. The Geoprocessing pane will appear on the right side of the screen.
3. In the Geoprocessing pane, type **Contour**.
4. Select **Contour (Spatial Analyst Tools)**.
5. From the Input raster drop-down menu, select **HST\_Interp\_NN**.
6. Under Output polyline features, type "**HST\_Interp\_NN\_Contour**".
7. Under Contour interval type "**10**".
8. Leave the **Base** contour as 0.
9. Leave the **Z factor** as 1. If you were using a different thickness than feet, you would want to input the conversion factor here.



10. When your Geoprocessing panel looks like this, click **Run**.

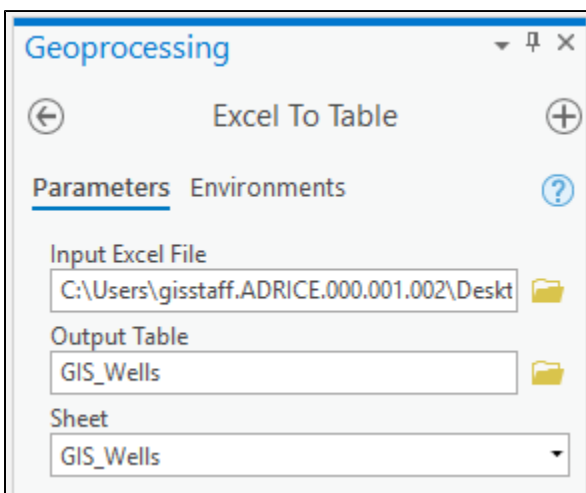


11. Above the Ribbon, on the Quick Access toolbar, click the **Save** button.

## Importing Excel Data

For more practice with displaying XY data, check out our short course: [Mapping Locations Using XY Coordinates](#). For more information on working with Excel in ArcGIS Pro, check out this help resource: [Work with Excel in ArcGIS Pro](#)

1. From the Ribbon, click the **Analysis** tab.
2. From the Analysis tab, in the Geoprocessing group, click the **Tools** button. The Geoprocessing pane will appear on the right side of the screen.
3. In the Geoprocessing pane, type **Excel to Table**.
4. Select **Excel to Table (Conversion Tools)**.
5. For Input Excel File, click the **Browse** button.
6. On the left side of the Browse window, click **Folders**.
7. On the right side of the Browse window, double click the **PlayMapping** folder and choose **IGOR\_masterlist**
8. Under Output Table, name the table **GIS\_Wells**.
9. From the Sheet drop down, choose the **GIS\_Wells** sheet. This ensures that the **GIS\_Wells** sheet will be the data converted from an excel table to a geodatabase table.
10. When your Geoprocessing panel looks like this, click **Run**.



11. In the Contents pane, right-click the **GIS\_Wells** table and select **Display XY Data**.
12. Name the layer "**GIS\_Wells\_Pts**".
13. Check that the X Field states "longitude" and the Y Field states "latitude".
14. For Coordinate System, use the dropdown menu to select **Current Map [GISWorkshop]**. The coordinate system should now be GCS\_North\_American\_1927.

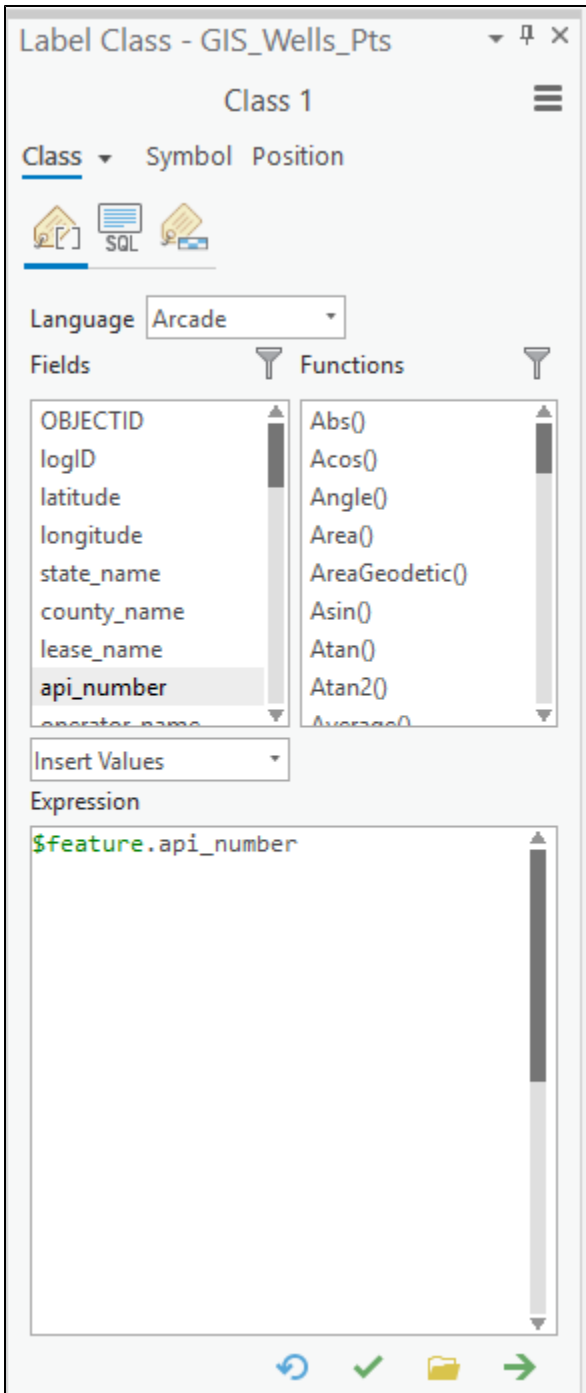
15. When your Geoprocessing pane looks like this, click **Run**.

The screenshot shows the 'Geoprocessing' pane with the 'XY Table To Point' tool selected. The 'Parameters' tab is active. The configuration is as follows:

- Input Table:** GIS\_Wells
- Output Feature Class:** GIS\_Wells\_Pts
- X Field:** longitude
- Y Field:** latitude
- Z Field:** (empty)
- Coordinate System:** GCS\_North\_American\_1927

16. In the Contents pane, right-click on **GIS\_Wells\_Pts** and select **Zoom to Layer**.
17. In the Contents pane, right-click **GIS\_Wells\_Pts** and select **Label**.
18. Right-click GIS\_Wells\_Pts and select **Label Properties**. A new pane, Label Class, will open on the right side of the screen.
19. Under the Expression box, clear the current input.
20. Under the Fields box, double click **api\_number**. The Expression box should now read **\$feature.api\_number**.

21. When your Label Class pane looks like this, click **Apply**.



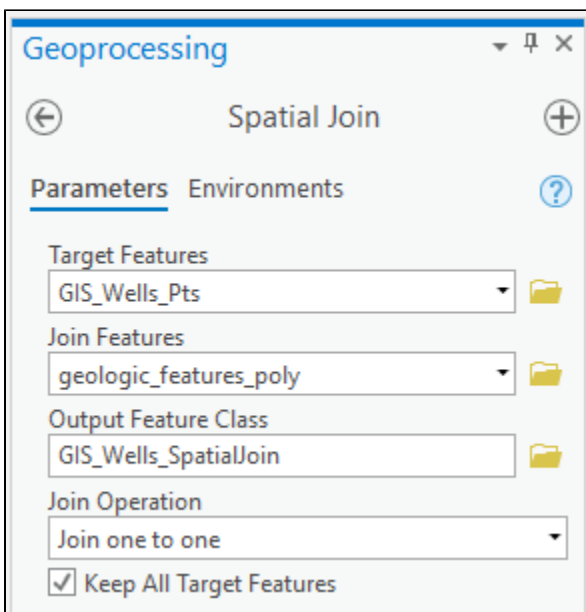
22. Above the Ribbon, on the Quick Access toolbar, click the **Save** button.

## Spatial Join

This section steps through how to joins attributes from one feature to another based on a spatial relationship. For more practice with Spatial Joins, check out our short course: [Introduction to Geoprocessing](#). For more information on Spatial Join in ArcGIS Pro, check out this tool reference: [Spatial Join](#)

1. In the Catalog pane, expand **PlayMapping.gdb**.
2. Right-click on **geologic\_features\_poly** and select **Add to Current Map**.
3. In the Contents pane, right-click on **geologic\_features\_poly** and select **Symbology**.
4. From the Symbology pane, use the dropdown menu to select **Unique Values**.
5. Change the Field 1 selection to **FEATURE**.
6. From the Color Scheme drop-down, select the color scheme that you would like.
7. From the Ribbon, click the **Analysis** tab.
8. From the Analysis tab, in the Geoprocessing group, click the **Tools** button. The Geoprocessing pane will appear on the right side of the screen.
9. In the Geoprocessing pane, type **Spatial Join**.

10. Select **Spatial Join (Analysis Tools)**.
11. Under Target Features, select **GIS\_Wells\_Pts**.
12. Under Join Features, select **geologic\_features\_poly**.
13. Rename the Output Feature Class as **GIS\_Wells\_SpatialJoin**.
14. Retain the default setting of **Join\_one\_to\_one** for the Join Operation.
15. Retain **all other default settings**.
16. When your Geoprocessing pane looks like this, click **Run**.



17. In the Contents pane, right-click on **GIS\_Wells\_Pts** and select **Remove**.
18. In the Contents pane, double-click on **GIS\_Wells\_SpatialJoin** and rename it **GIS\_Wells**.
19. Above the Ribbon, on the Quick Access toolbar, click the **Save** button.