Edition 2015

THE FAUQUIER COUNTY GIS TRAINING MANUAL

A COMPREHENSIVE INTRODUCTION TO FAUQUIER COUNTY GIS

GEOSPATIAL SOLUTIONS

Introduction to ArcMap 10.2

Fauquier County, VA

This section provides an introduction and overview to ArcMap, which is the central application used in ArcGIS. ArcMap is where you display and explore GIS datasets for your study area, where you assign symbols, and where you create map layouts for printing or publication. ArcMap is also the application you use to create and edit datasets.

ArcMap represents geographic information as a collection of layers and other elements in a map. Common map elements include the data frame containing map layers for a given extent plus a scale bar, north arrow, title, descriptive text, a symbol legend, and so on.

Typical tasks performed in ArcMap

ArcMap is the primary application used in ArcGIS and is used to perform a wide range of common GIS tasks as well as specialized, user-specific tasks. Here is a list of some common workflows you can perform:

- **Work with maps**—you can open and use ArcMap documents to explore information, navigate around your map documents, turn layers on and off, query features to access the rich attribute data that is behind the map, and to visualize geographic information.

- **Print maps**—you can print maps, from the simplest to very sophisticated cartography, using ArcMap.

- **Compile and edit GIS datasets**—ArcMap provides one of the primary ways that users automate geodatabase datasets. ArcMap supports scalable full-function editing. You select layers in the map document to edit and the new and updated features are saved in the layer's dataset.

- **Use geoprocessing to automate work and perform analysis**—GIS is both visual and analytical. ArcMap has the ability to execute any geoprocessing model or script as well as to view and work with the results through map visualization. Geoprocessing can be used for analysis as well as to automate many mundane tasks such as map book generation, repairing broken data links in a collection of map documents, and to perform GIS data processing.

- **Organize and manage your geodatabases and ArcGIS documents**—ArcMap includes the Catalog window that enables you to organize all of your GIS datasets and geodatabases, your map documents and other ArcGIS files, your geoprocessing tools, and many other GIS information sets. You can also set up and manage geodatabase schemas in the ***Catalog*** window.

- **Publish map documents as map services using ArcGIS for Server**—ArcGIS content is brought to life on the web by publishing geographic information as a series of map services. ArcMap provides a simple user experience for publishing your map documents as map services.

- **Share maps, layers, geoprocessing models, and geodatabases with other users**—ArcMap includes tools that make it easy to package and share GIS datasets with other users. This includes the ability to share your GIS maps and data using ArcGIS Online.

- **Document your geographic information**—A key goal in GIS communities is to describe your geographic information sets to help you document your projects and for more effective search and data sharing. Using the Catalog window, you can document all of your GIS contents. For organizations who use standards-based metadata, you can also document your datasets using the ArcGIS metadata editor.

- **Customize the user experience**—ArcMap includes tools for customization, including the ability to write software add-ins to add new functionality, to simplify and streamline the user interface, and to use geoprocessing for task automation.

Throughout this manual, the user can expect to find the most common tools and toolbars provided with a description of what the tool or toolbar is used for; what functions can be executed using the tool.

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How to start ArcMap:

To start ArcMap the user needs to first access verify that ArcGIS 10.2 is loaded onto their computer by identifying the ArcGIS 10.2 icon from the START menu or on the desktop:

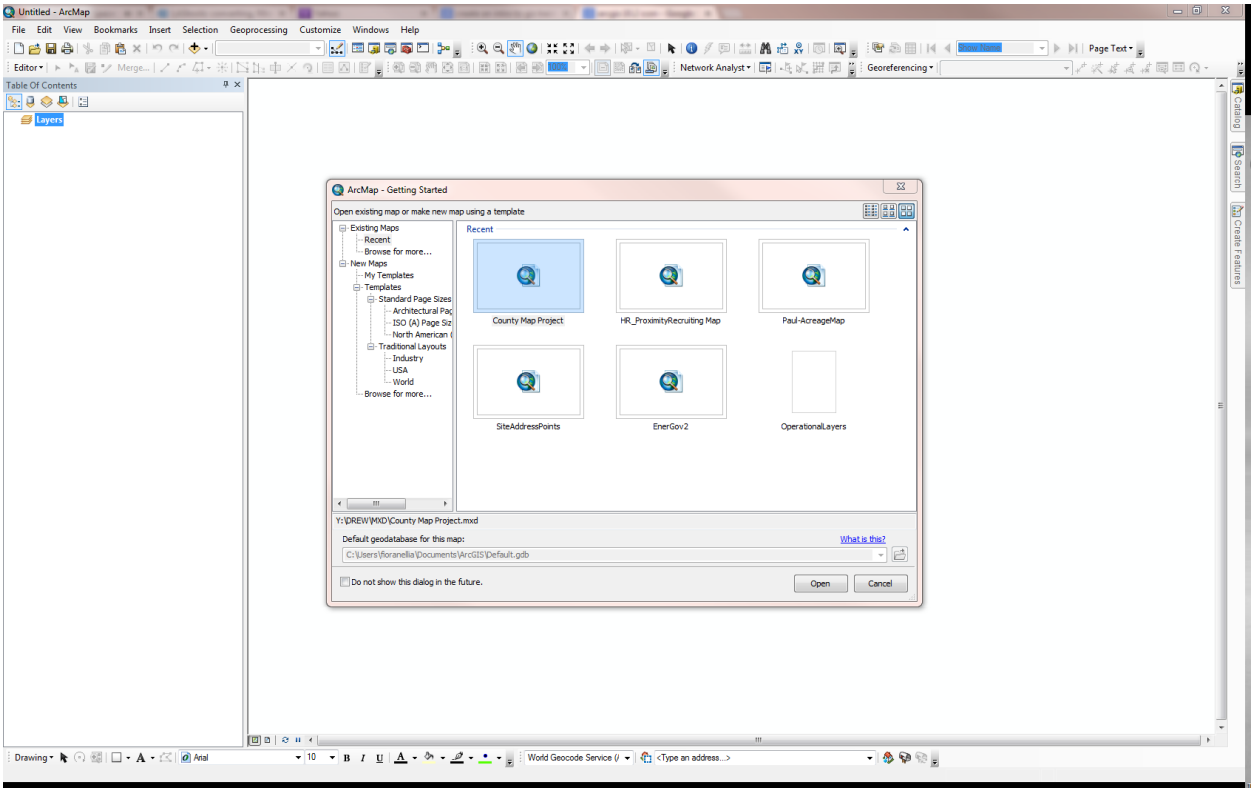
ArcMap 10.2

Once in ArcMap, the user can being the process of creating custom maps or used for viewing geospatial data. Most spatial data will be in the form of a shapefile or geodatabase, but spatial data can also be a table, a CAD drawing file, or the multiple file formats used with spatial data collectors (GPS data collector).

How to create a map:

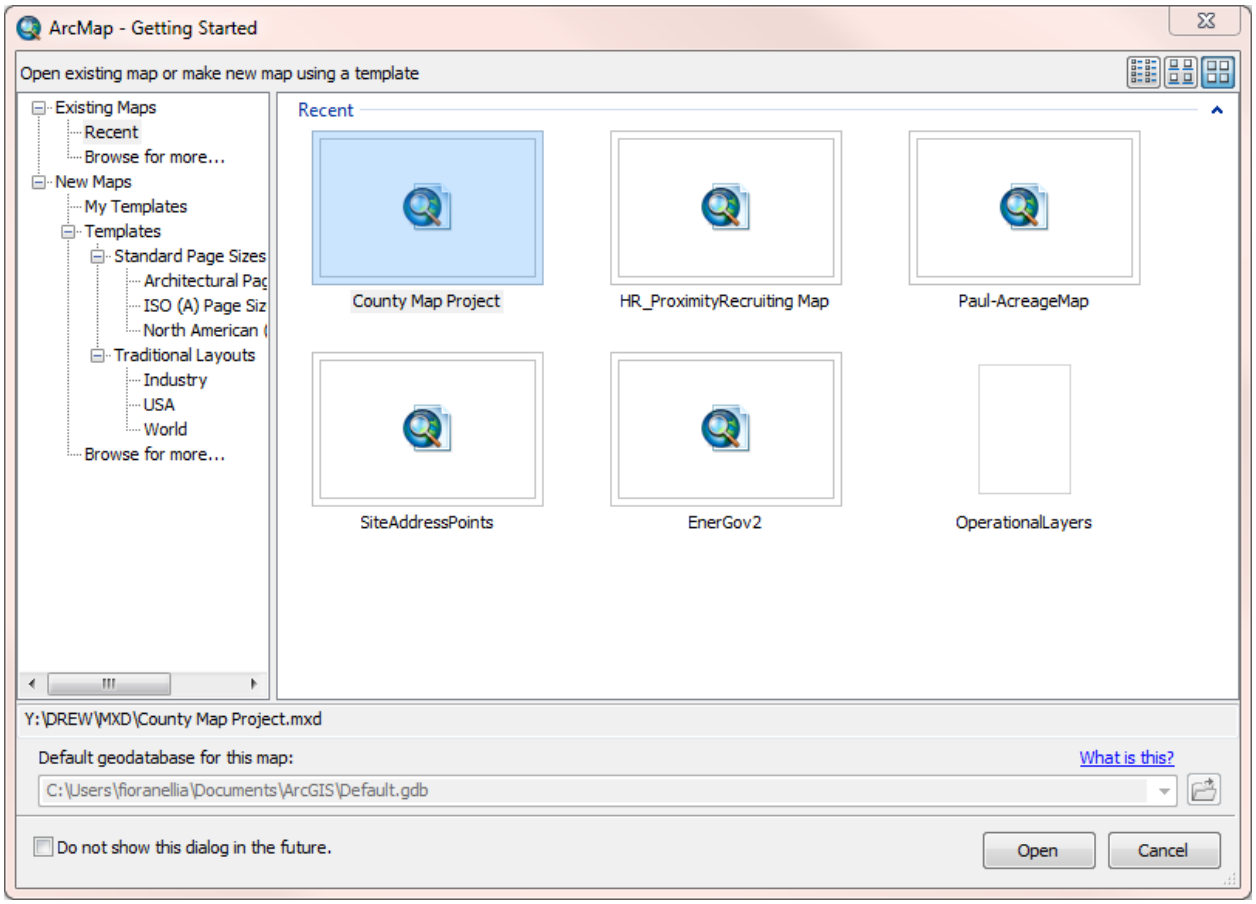
Start ArcMap by double-clicking on the ArcMap icon on your desktop. If an icon is not present, you can use the Start Menu instead. Usually, you will find ArcMap if you click on:

START BUTTON> PROGRAMS> ARCGIS> ARCMAP 10.2



b) When the "Getting Started" window pops up, the user can create a new map from scratch or open an existing or previously viewed map. All previously opened maps will be displayed in the blank space with the title of the mapping project displayed.

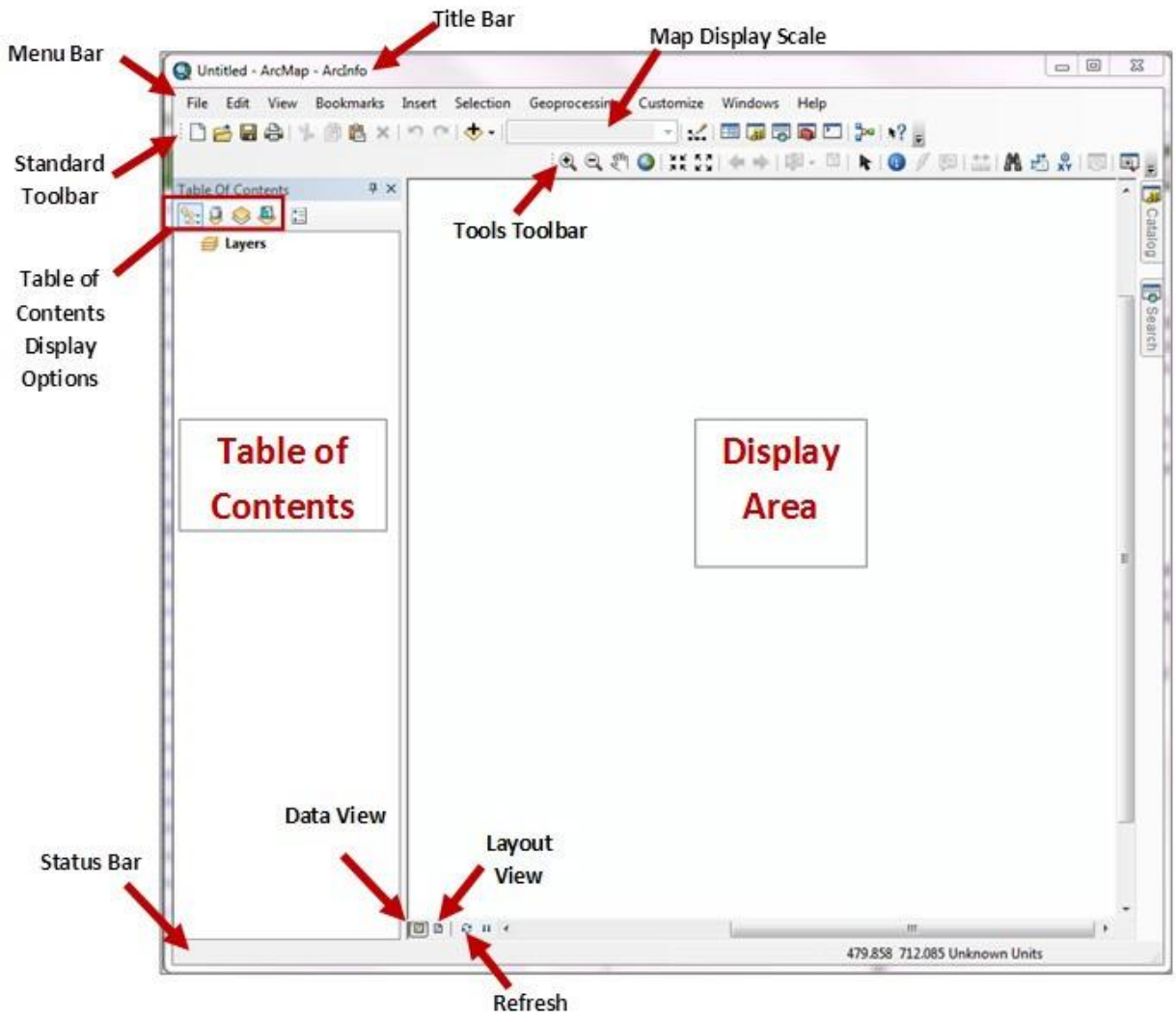
c) Select "Cancel" to start a new mapping project if you are not going to use an existing mapping project.



The ArcMap Graphical User Interface (GUI) will look something like what you see below. If it looks slightly different, it's because additional functionality (toolbars, etc.) may have been turned on or enabled by a previous user. When ArcMap is closed, it "remembers" these settings and restores them when it is reopened.

Explore the ArcMap Interface. As you hold the mouse pointer over a button, a description of its function will appear in a small box below it. Additionally, a brief explanation of what it does will appear in the status bar in the lower right corner of the ArcMap GUI. Take a few minutes to try out this technique. As you mouse over some of the icons and buttons, try to familiarize yourself with what each one does.

Some of the major "areas" of the ArcMap interface are labeled below.



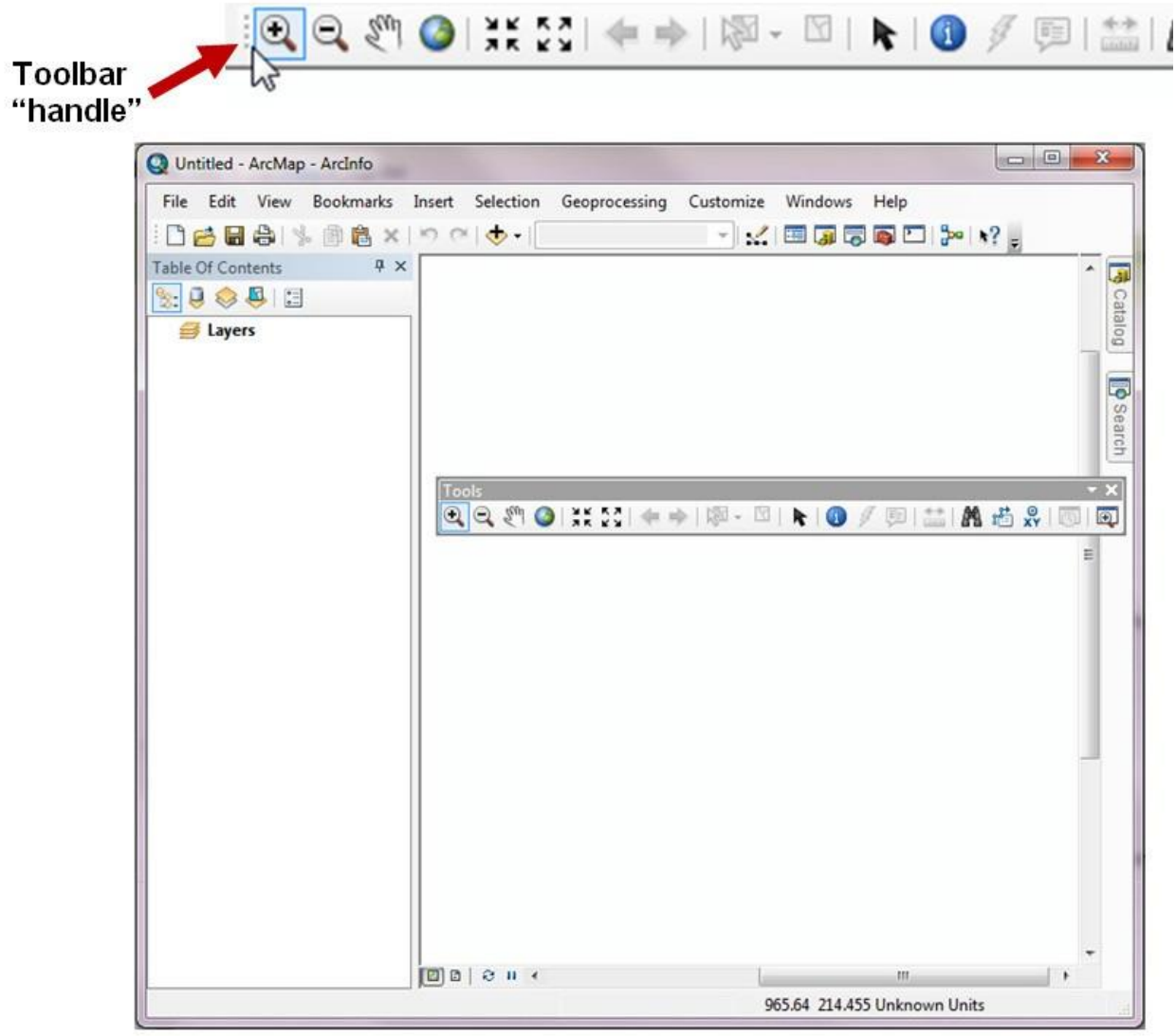
Toolbars:

Toolbars in ArcMap, found under the "Customize" tab at the top of your map window, are sets of tools that perform similar types of functions. The Tools toolbar includes tools for navigating around the map display and tools for performing basic query functions. When opened, all toolbars will present in a free floating state, meaning they will appear on the screen and you can move them around as you see fit. You should know that all toolbars are dock able as well. Select and hold the heading of the toolbar and drag the toolbar around your screen to dock the toolbar on the panel at the top, bottom, side of the screen for better organization.

When you save your .mxd and return to your map at a later date, or when you start a new map, your interface will appear the same as you left it during your previous session. This helps saves time with loading toolbars or remembering what processing tools where used to create your map.

Try moving the Tools toolbar around the ArcMap window. You can even drag it to a location on your desktop that's completely off the ArcMap GUI; just try not to lose it!

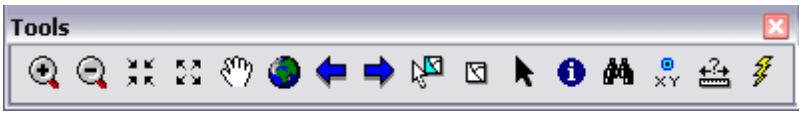
The most common toolbars used will follow with an explanation of what each icon (tool) on the toolbar with performs when selected.



The Standard Toolbar: most typically appears at the top of the ArcMap application window and is used for map printing, creating a new map, opening an existing map, saving your map, starting related ArcGIS applications, and more.

Button	Name	Function
	New map file	Creates a new map
	Open	Opens an existing map
	Save	Saves the current map
	Print	Prints the current map
	Cut	Cuts the selected element(s)
	Copy	Copies the selected element(s)
	Paste	Pastes the clipboard contents into your map
	Delete	Deletes the selected element(s)
	Undo	Undoes the last action
	Redo	Redoes the previously undone action
	Add Data	Adds new data to the map's active data frame
1:53,561,939	Scale	Define a scale by manually entering it into the Scale box
	Editor toolbar	Shows the Editor toolbar so you can edit the map's data
	Launch ArcCatalog	Starts ArcCatalog
	Show/Hide ArcToolbox	Shows/Hides the ArcToolbox window
	What's This?	Allows you to get help for a menu command or tool by clicking the What's This pointer and clicking the menu command or tool

Tools Toolbar: is where the zoom in/out, pan and select tools can be found.

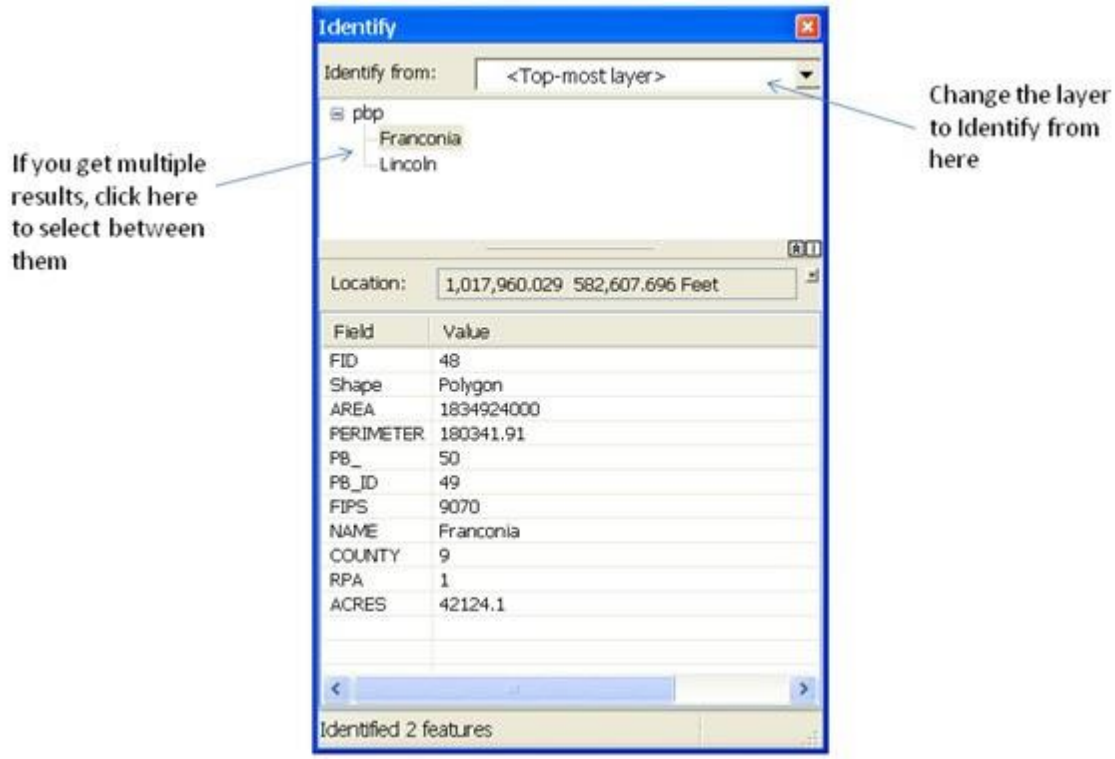


Button	Name	Function
	Zoom In	Allows you to zoom in to a geographic window by clicking a point or dragging a box
	Zoom Out	Allows you to zoom out from a geographic window by clicking a point or dragging a box
	Fixed Zoom In	Allows you to zoom in on the center of your data frame
	Fixed Zoom Out	Allows you to zoom out on the center of your data frame
	Pan	Allows you to pan the data frame
	Full Extent	Allows you to zoom to the full extent of your map
	Back	Allows you to go back to the previous extent
	Forward	Allows you to o forward to the next extent
	Select Features	Allows you to select features by clicking or dragging a box
	Clear Selected Features	Deselects all of the currently selected features in the active data frame
	Select Elements	Allows you to select, resize, and move text, graphics, and other objects placed on the map
	Identify	Identifies the geographic feature or place on which you click
	Find	Finds features in the map
	Go To XY	Allows you to type an x,y location and navigate to it
	Measure	Measures distance on the map
	Hyperlink	Triggers hyperlinks from features

The Identify button, on the Tools toolbar, can be very handy – it will report to you all of the attributes for any feature that you click on in your map. By default it works on the top-most visible layer in your TABLE OF CONTENTS, but you can set it to identify features from a specific layer, from all visible layers, or from all layers.

Click on the IDENTIFY button in the TOOLS TOOLBAR, and then click somewhere in your map. If roads are visible, then you will get information for whatever feature you clicked on – a road or a town.

Experiment with drawing a box with the IDENTIFY button (this will give you multiple results) and with changing the layers that the tool works on.



Editor Toolbar: contains the various commands you will need to edit your data. From the Editor Toolbar, you can start and stop an edit session, create new features and modify existing ones, and save your edits.

Button	Name	Function
	Edit	Selects and edits features and their geometries
	Sketch	Adds points to the edit sketch
	Intersection	Intersects two line segments to create a new point
	Arc	Creates a circular arc segment
	Midpoint	Creates a new point at the midpoint of a line
	Endpoint Arc	Creates a circular arc segment
	Tangent	Constructs a tangent curve
	Distance-Distance	Creates a point at the intersection of two distances from two other points
	Direction-Distance	Creates a point at the intersection of a direction from one point and a distance from another point
	Trace	Adds points to the edit sketch by tracing existing features
	Split Tool	Splits a linear feature
	Rotate Tool	Rotates the selected feature
	Attributes	Shows the feature property editor

	Sketch Properties	Shows a dialog box for editing properties of the edit sketch geometry

How to Find Tools:

There are two basics ways to find tools:

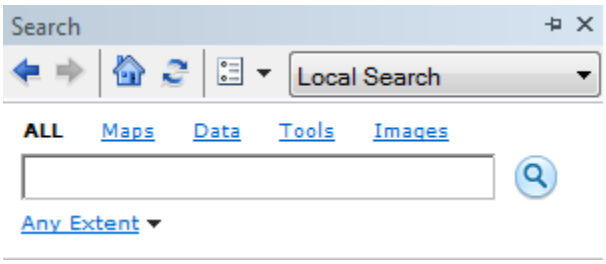
- Search using the ***Search*** window.
- Browse using the ***Catalog*** or ***ArcToolbox*** window.

In addition, tools can be found on menus and toolbars. ArcGIS is installed with a few commonly used tools on the **Geoprocessing** menu, and you can add tools to any menu or toolbar.

Using the Search window to search for tools

To open the ***Search*** window, do one of the following:

- Click **Geoprocessing** > **Search For Tools**.
- Click the Search button.
- Click **Windows** > **Search**.
- Press CTRL+F.

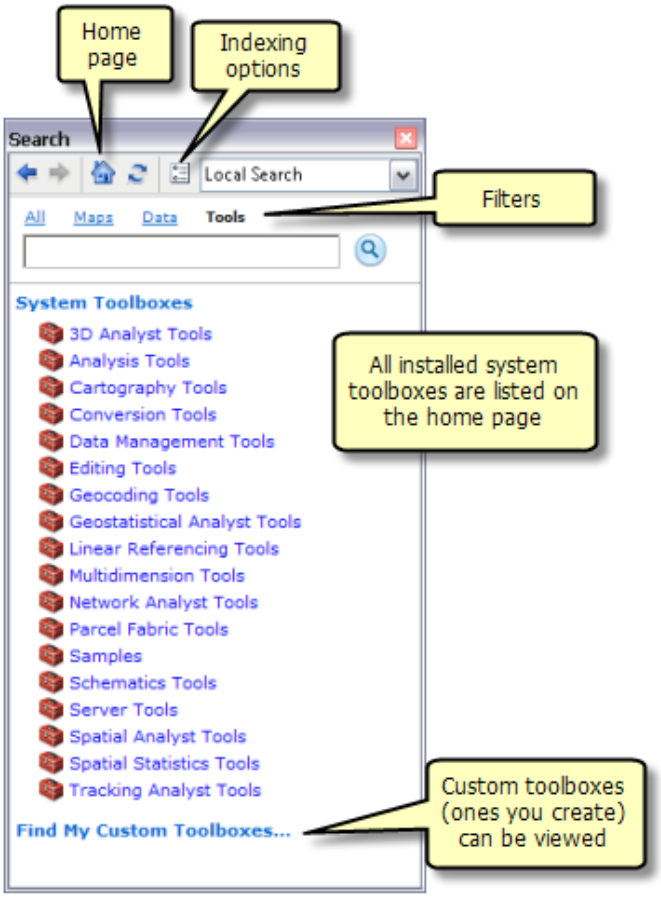


Tool home page

As illustrated below, the ***Search*** window has four filters: **All**, **Maps**, **Data**, and **Tools**. Both the **All** and **Tools** filters will return tool results. When searching for tools, the best results are obtained using the **Tools** filter.

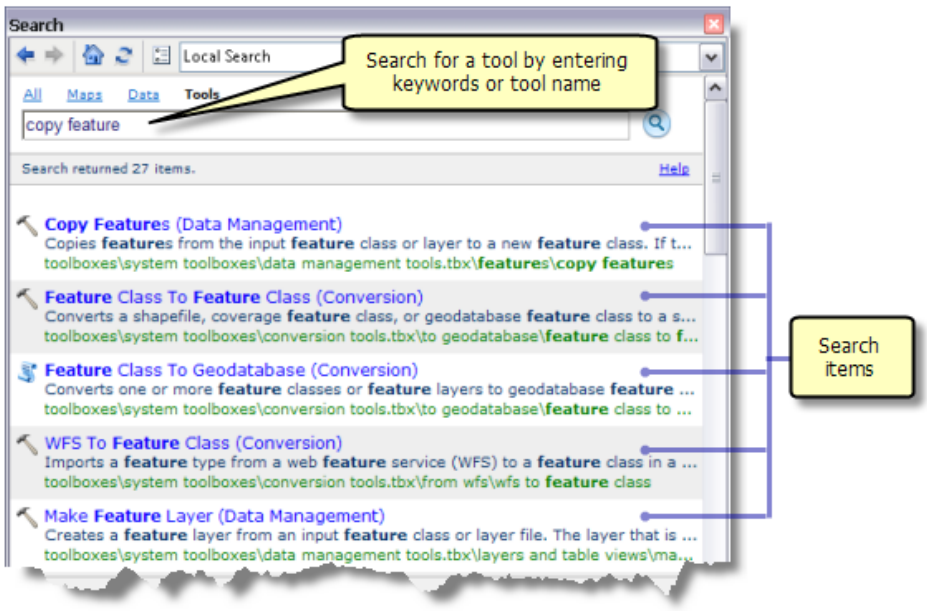
The ***Search*** window Home page button takes you to the geoprocessing tools home page, illustrated below. The home page lists all installed system toolboxes. You can click the toolbox name to examine the contents of the toolbox—its toolsets and tools. Custom toolboxes (toolboxes that you create) can be examined by clicking the **Find My Custom Toolboxes** link.

Note: Only those custom toolboxes in folders that you index can be found in the ***Search*** window. To add a folder to the search index, click the Indexing Options button.



Searching by name or keyword

If you know the name of a tool, you can enter it in the ***Search*** window. If you don't know the name of a tool but can think of some words that describe what you want the tool to do, you can enter the words and search for all tools that match the words.

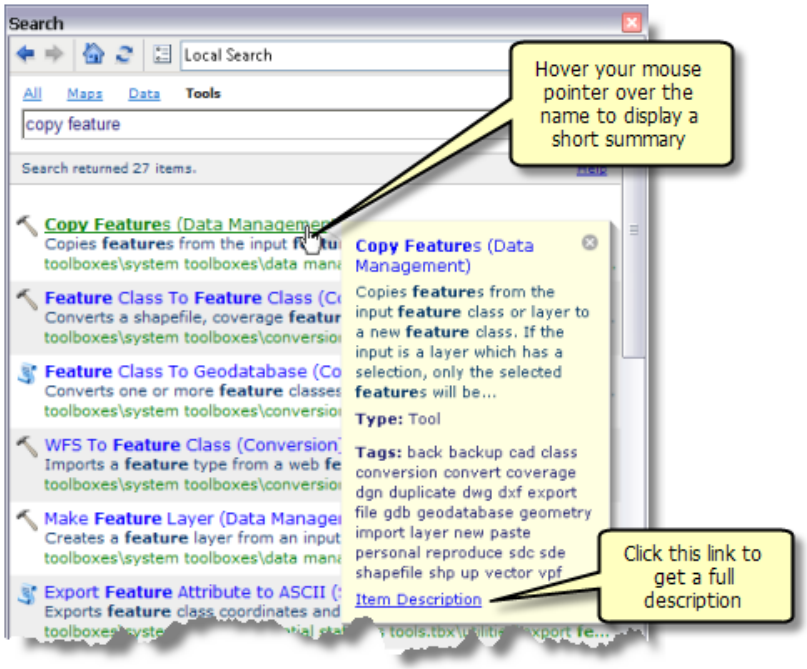


Tip:

You can type the first few letters of a tool name to populate the drop down list. You can then highlight an entry in the drop down list using the up and down arrow keys or your mouse. Once you've highlighted the tool, press CTRL+ENTER to open the tool dialog.

Working with a search result

There are a number of things you can do with a search item. If you pause the pointer on the item, a short description of the toolbox, tool, or geoprocessing package will be displayed (toolsets do not have descriptions), as illustrated below. The **Item Description** link in the short description will open the description of the toolbox, tool, or geoprocessing package. You can also open the item description by clicking the first line of text below the tool name.



In addition to the Main menu and the Standard toolbar, the Desktop applications have other toolbars that contain commands to help you perform a group of related tasks.

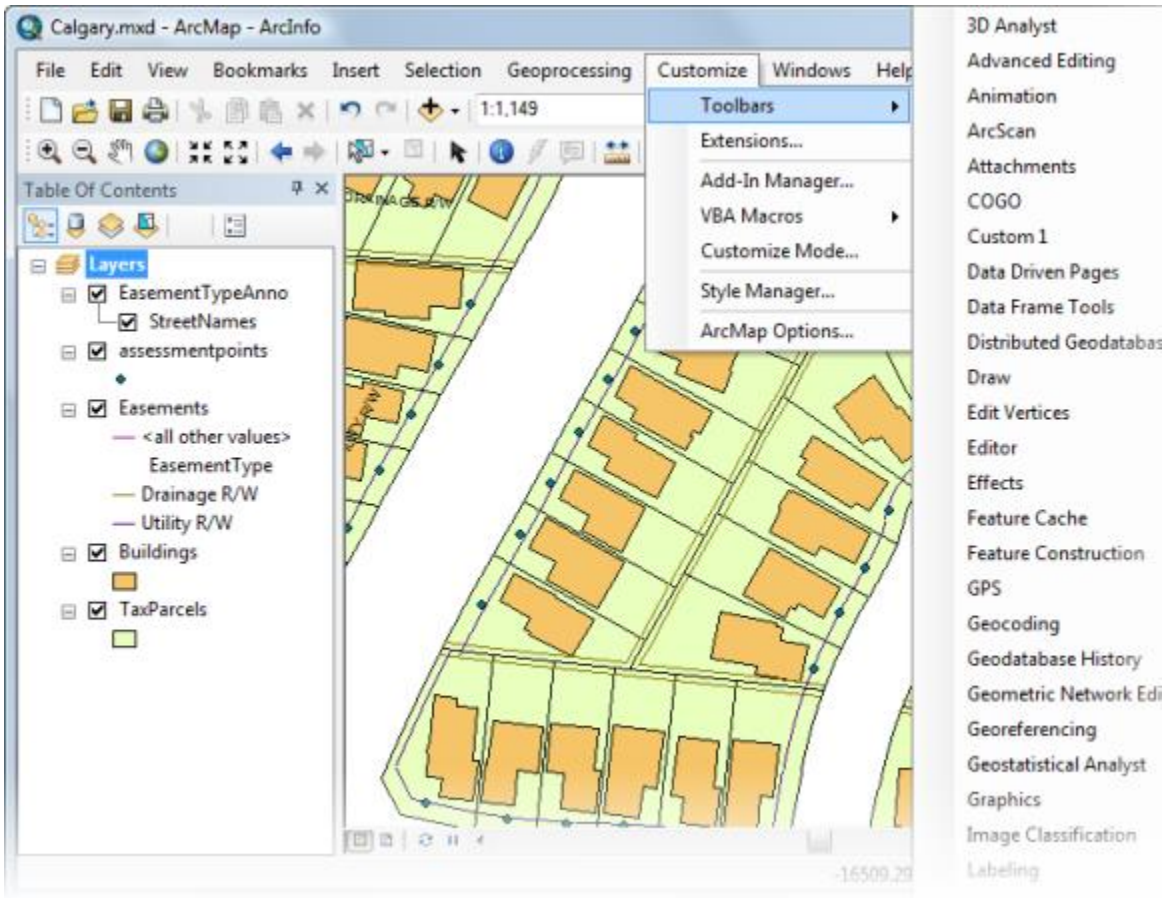
Hiding and Showing Toolbars

Toolbars are easily repositioned by dragging them to your desired location. Toolbars can either float on the desktop or dock along the outer edges of the application. You don't need to be in customize mode to move a toolbar.

Toolbar visibility and position information are stored in the Normal template by default. Therefore, all documents that are based on the Normal template—the default—experience the same toolbar layout. The toolbar layout from the previous session is fully restored after you restart the application; toolbar information is automatically maintained, so you do not need to press the Save document button.

Steps:

1. Click **Customize** on the main menu and point to **Toolbars**.
2. Check a toolbar to show it.



3. Optionally, uncheck a toolbar to hide it.

Note: You can access the toolbars list without using the Customize menu. Simply right-click anywhere in the toolbar docking area at the top of the application or directly on a toolbar.

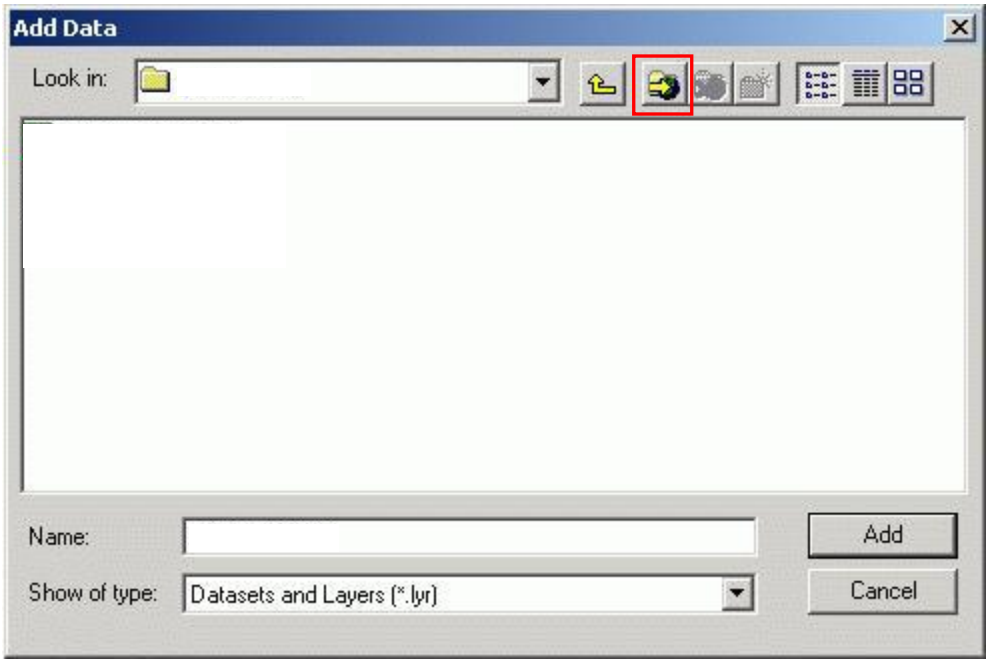
How to add data:

Now that you know what tools you will be working with and how to locate them it's time to identify how to find and add spatial data to a new map document or an existing map document.

The first button you need to know about…

There are actually two buttons you need to know about but the first leads to the second. Identify the black plus sign with the yellow triangle behind it. It will look like the following:

Use this button to add layers to your map. Click on the button to reveal the Add Data Window:



From this dialog, you will use the "connect to folder" button to navigate to your user storage folder or the Fauquier County geodatabase folder to add data. 

There are five types of data that you will be using:

- points (vector)
- lines (vector)
- polygons (vector)
- grids (raster)
- imagery (raster)

Using Folder Connections

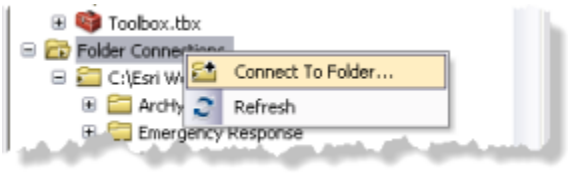
It's a good idea to organize GIS content into a set of commonly used workspace folders. These are file folders on disk used to organize your GIS projects. They contain map documents, layers, file geodatabases, geoprocessing tools, scripts, and so on.

An initial task in using the ***Catalog*** window is to establish a series of connections to the workspace folders whose content you plan to work with in ArcGIS. Each map has a Home folder, which is the folder in which the map document is stored. You can use the Home folder as the common location for organizing many of the contents used in your map document, such as a file geodatabase and its datasets, layer files, and other GIS information related to your map.

Steps for creating additional folder connections

The ***Catalog*** window gives you a mechanism for connecting to and working with GIS information in a number of workspace folders. The initial task is to establish a folder connection to each.

1. Navigate to the **Folder Connections** node in the catalog window tree.
2. Right-click the node and choose **Connect To Folder**.



3. Type the path or navigate to the desired workspace folder and click **OK**.

Tip:

You can create a new folder connection by dragging a folder from the tree view onto the Folder Connections node.

Working with folder connections in the Catalog window

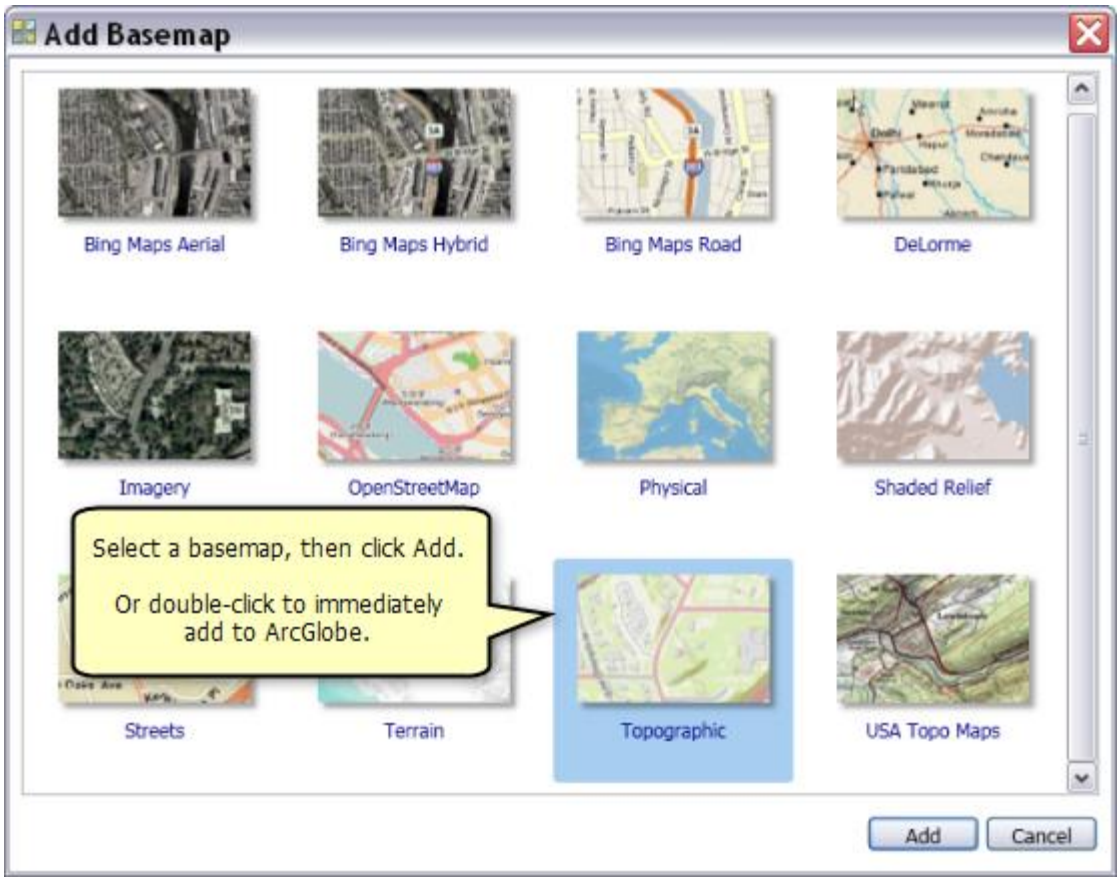
Once you have established a folder connection, you can use the ***Catalog*** window to navigate the contents of the folder. For example:

- Double-click a map document to open it in ArcMap.
- Add data to ArcMap by dragging datasets and layer files into the data frame. Use the same procedure to add items to a geoprocessing tool or into ***Model Builder***.
- Right-click an item and select **Item Description** to view its metadata.

A feature that ESRI has added in ArcGIS 10.2 is the ability to add 3D basemaps to your globe document, which are accessed from ArcGIS Online. Basemaps change the way you want the overall globe to appear and may consist of one or many layers. The gallery of basemaps includes the key ArcGIS Online basemaps, such as World Imagery, World Streets, and World Topographic Map, as well as the Bing Maps services and many more. These basemaps all

require an Internet connection for them to be drawn in your globe. This makes it quick and easy to immediately add great basemaps to your view without having to download or manage the data locally. The content in these services is frequently updated, too.

Click the drop down arrow next to the Add Data button and click Add Basemap



Coordinate Systems and Map Projections:

The Earth is not a perfect sphere. Different Spheroids (Earth models) have been devised to model the earth- they are distinguished by the length of their axes. Different coordinate systems and map projections are used to account for the Spheroid of the Earth. Projected Coordinate Systems mathematically transform the 3 dimensional earth so that it can be modeled in 2 dimensions.

To display your data correctly, each data frame uses a coordinate system. It determines the map projection for the map display in the data frame. The data frame's coordinate system need not be the same as the data you are using, although if ArcMap has to project your data on the fly, it can take longer to draw.

When ArcMap is started with a new, empty map, the coordinate system for the default data frame is not defined. The first layer added to an empty data frame sets the coordinate system for the data frame, but you can change it if necessary. As you add subsequent layers, they are automatically displayed using the data frame's coordinate system as long as the data source's coordinate system is defined.

If there isn't enough information, ArcMap will be unable to project the data in each layer and display it correctly. In this case, you'll have to supply the necessary coordinate system information yourself.

Generally, if you have a layer whose dataset does not have a coordinate system defined and you know which coordinate system it is using, you should use the Define Projection tool in ArcToolbox to assign projection information to your data. This is required for working with that data in ArcGIS.

In Fauquier County we utilize the VA State Plane Coordinate System. State Plane- a coordinate system that divides the United States, Puerto Rico and U.S. Virgin Islands into >120 zones. VA State Plane NAD83 is used by most local data providers and what most data used in Fauquier County is project in.

Project Coordinate System: NAD1983 State Plane Virginia North FIPS 4501 Feet
Projection: Lambert Conformal Conic

> **Tip:** To see if your data source has a coordinate system defined, right-click the layer in the ArcMap table of contents, and click **Properties** to open the ***Layer Properties*** dialog box. Click the **Source** tab, then look in the **Data Source** box. You can also use the ***Catalog*** window to see if your data has a coordinate system defined.

How to identify a layers coordinate system

1. Right click on the title of your layer in the Table of Contents of ArcMap. Choose Properties at the bottom of the pop up menu.
2. Click on the Source tab.

3. Scroll down the Data Source section, there should be a label that says Geographic Coordinate System or Projected Coordinate System. This tells you which Coordinate System this map layer uses.
4. Check all of your other Map Layers to make sure that they are using the same Coordinate System. If not, use the directions below to change the Coordinate Systems to match one another.

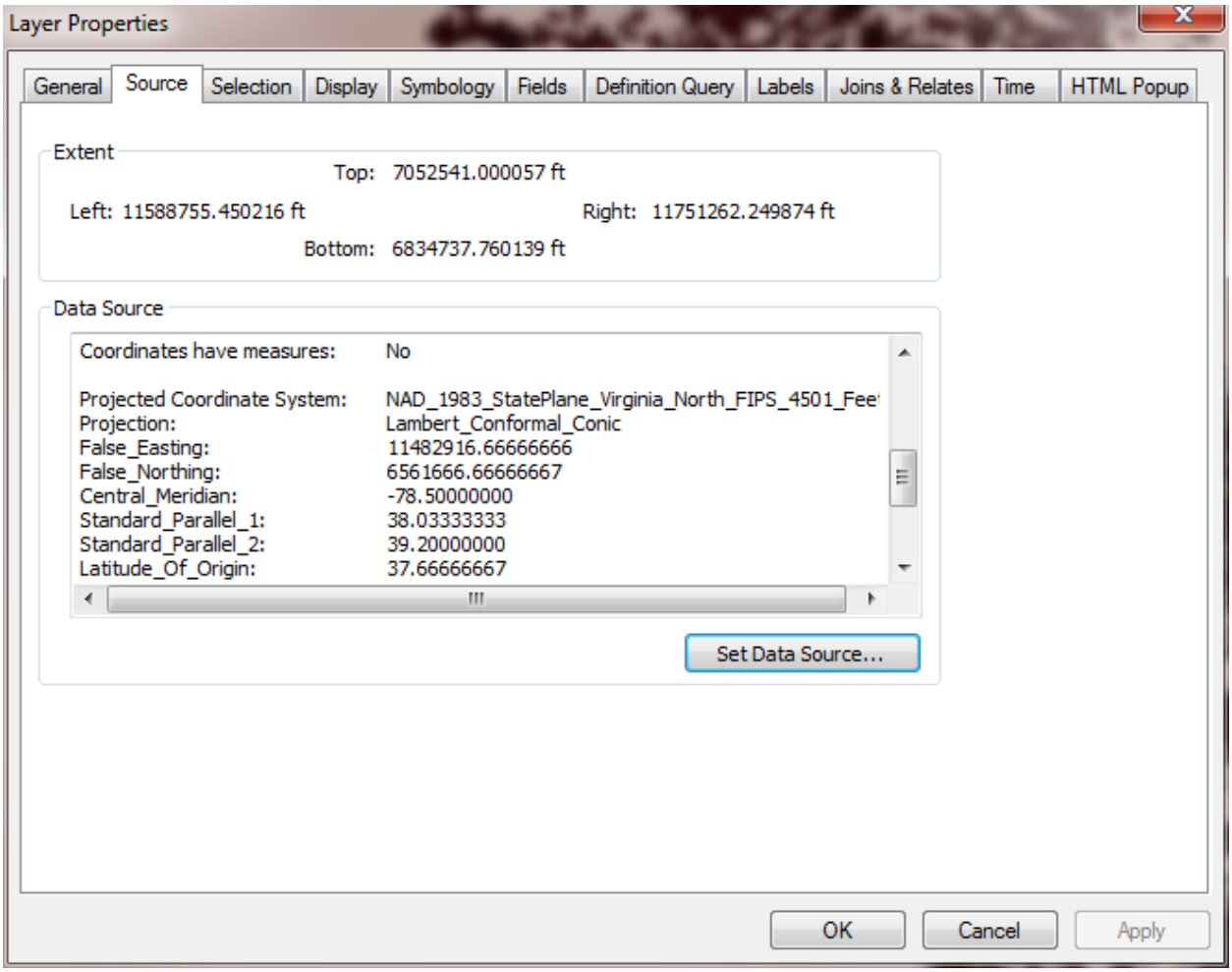


Table of Contents:

Every map has a table of contents. The table of contents contains entries for the data used in the map. The **table of contents** is used primarily to turn layers on and off, access the properties of layers, and rearrange layers to change the drawing order. You can display the table of contents with the Display, Source, or Selection tabs.

The **Display** tab shows the layers in each data frame with the layers sorted by drawing order. Layers at the top of the list are drawn on top of layers lower in the list. You can drag layers up and down in the list to control the drawing order. In the example graphic, the hillshade.img raster layer draws under the other layers since it's at the bottom of the list of layers.

The **Source** tab shows the layers in each data frame with the layers organized by the folders or databases in which the data sources referenced by the layers can be found. This view will also list tables that have been added to the map document as data.

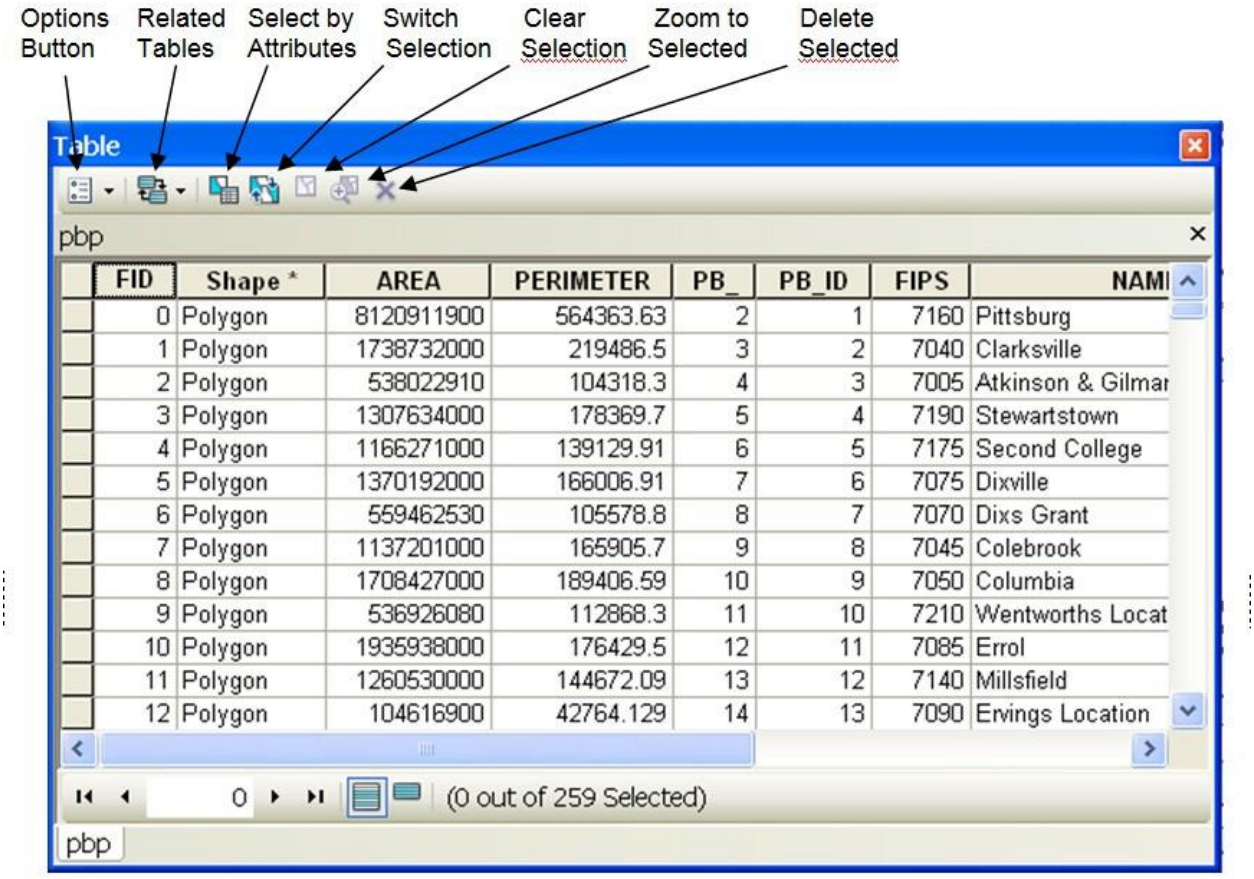
The **Selection** tab shows a list of the layers in the active data frame and lets you check the ones you want to make selectable. This tab works like the Set Selectable Layers dialog box accessed from the Selection menu.

You can adjust the look of the table of contents. For example, you might change the text size and font so that it makes a greater visual impact or is easier to read, or you might want to change the shape of the lines and patches that represent the features on a map. You can also dock the table of contents to the ArcMap interface, or you can make it a floating window as in the graphic above.
If you ever accidently **close the table of contents, open the "WINDOWS" tab located at the top of the map and select table of contents. The will table of contents will appear as a free floating window. Dock the window to the left side of the screen.*

Attribute Table:

Tabular information is the basis of geographic features, allowing you to visualize, query, and analyze your data. In the simplest terms, tables are made up of rows and columns, and all rows have the same columns. In ArcGIS, rows are known as records and columns are fields. Each field can store a specific type of data such as a number, date, or piece of text.

Feature classes are really just tables with special fields that contain information about the geometry of the features. These include the Shape field for point, line, and polygon feature classes and the BLOB field for annotation and dimension feature classes. Some fields, such as the unique identifier number (ObjectID) and Shape, are automatically added, populated, and maintained by ArcGIS.



FID	Shape *	AREA	PERIMETER	PB_	PB_ID	FIPS	NAMI
0	Polygon	8120911900	564363.63	2	1	7160	Pittsburg
1	Polygon	1738732000	219486.5	3	2	7040	Clarksville
2	Polygon	538022910	104318.3	4	3	7005	Atkinson & Gilmar
3	Polygon	1307634000	178369.7	5	4	7190	Stewartstown
4	Polygon	1166271000	139129.91	6	5	7175	Second College
5	Polygon	1370192000	166006.91	7	6	7075	Dixville
6	Polygon	559462530	105578.8	8	7	7070	Dixs Grant
7	Polygon	1137201000	165905.7	9	8	7045	Colebrook
8	Polygon	1708427000	189406.59	10	9	7050	Columbia
9	Polygon	536926080	112868.3	11	10	7210	Wentworths Locat
10	Polygon	1935938000	176429.5	12	11	7085	Errol
11	Polygon	1260530000	144672.09	13	12	7140	Millsfield
12	Polygon	104616900	42764.129	14	13	7090	Ervings Location

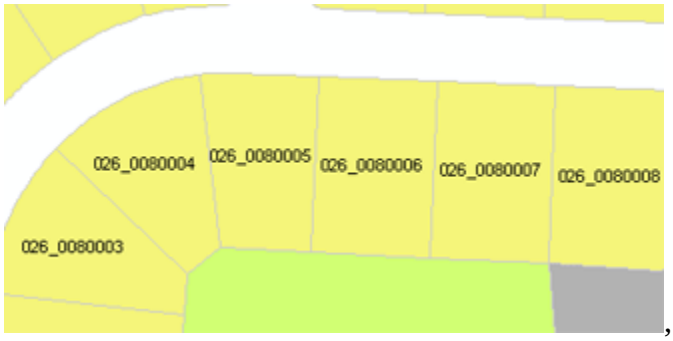
ArcGIS allows you to associate records in one table to records in another table through a common field, known as a key. You can make these associations in several ways including by joining or relating tables temporarily in your map or by creating relationship classes in your geodatabase that maintain more permanent associations. For example, you could associate a table of parcel ownership information to the parcels layer, since they share a parcel ID field.

To access the attribute table, right click the selected layer in the table of contents and select attribute table.

As an aside, the following will provide examples of the importance of attributes and the attribute table:

There are many mapping, analysis, and data management tasks you can perform using tabular data.

Tables allow you to map and visualize your data. For example, you can classify or categorize attributes to symbolize a layer. You can use population values to symbolize major cities with a larger symbol than used for smaller towns and villages. You can also specify that a different color be used to represent each type of land use in a parcel layer. In addition, you can also use the attribute values to generate text to label each parcel feature. In the graphic below, the parcels are symbolized by the type of land use, and then labeled with their parcel ID values.



,

When information in your geodatabase changes, you can update your attributes when in an edit session. For example, you'll need to update your database when land uses or property ownership changes—or the unknown values are classified. If you have a feature class representing some pipes with a field for the diameter, you can easily change the attributes when the crew removes an eight-inch and replaces it with a six-inch pipe. You can edit tabular values either within the table window or the Attributes dialog box, which shows attributes of only individual selected features.

How to select features:

It may seem strange to focus on the task of selecting features based on their attributes or location, but in fact, making selections is a very useful way to examine your data, and is a frequent first step in analyses. For example, if you were working on a project based in a specific town, your first step might be to zoom to that town in your view. You could do that by first selecting the

town, and then choosing to zoom to your selected feature. Your next task might be to sub-set a number of statewide datasets (such as roads or streams) to just the area of your town. To accomplish this, you would also need to first have your town selected.

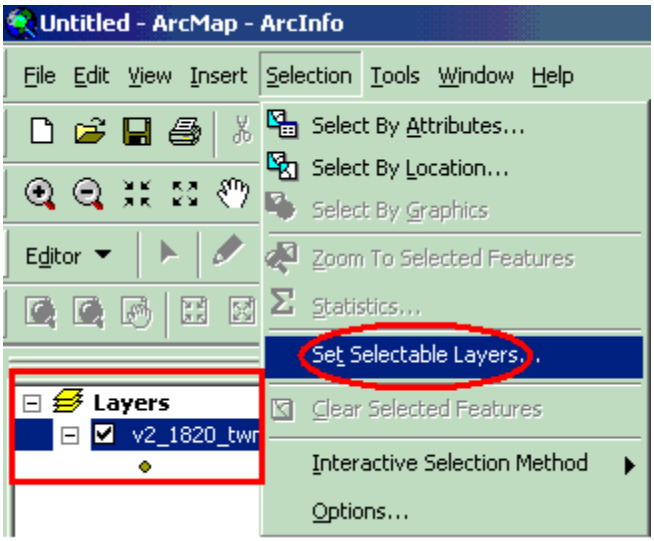
Use Select Features Tool
If it's not already open, open ArcMap and the map you were working on earlier: Exercise1.mxd.

Click on the SELECT FEATURES tool on the TOOLS toolbar, and then click on a feature in your map. 

Any feature or features that you selected should now be outlined in bright turquoise.

Set Selectable Layer(s)

Particularly when using the Select Features tool, it can be very difficult to figure out what you've selected once you have clicked somewhere. In the step above, you may have selected some roads and a town or two with just one click of the tool. There is, however, a handy way to control what can get selected: the List by Selection tab.

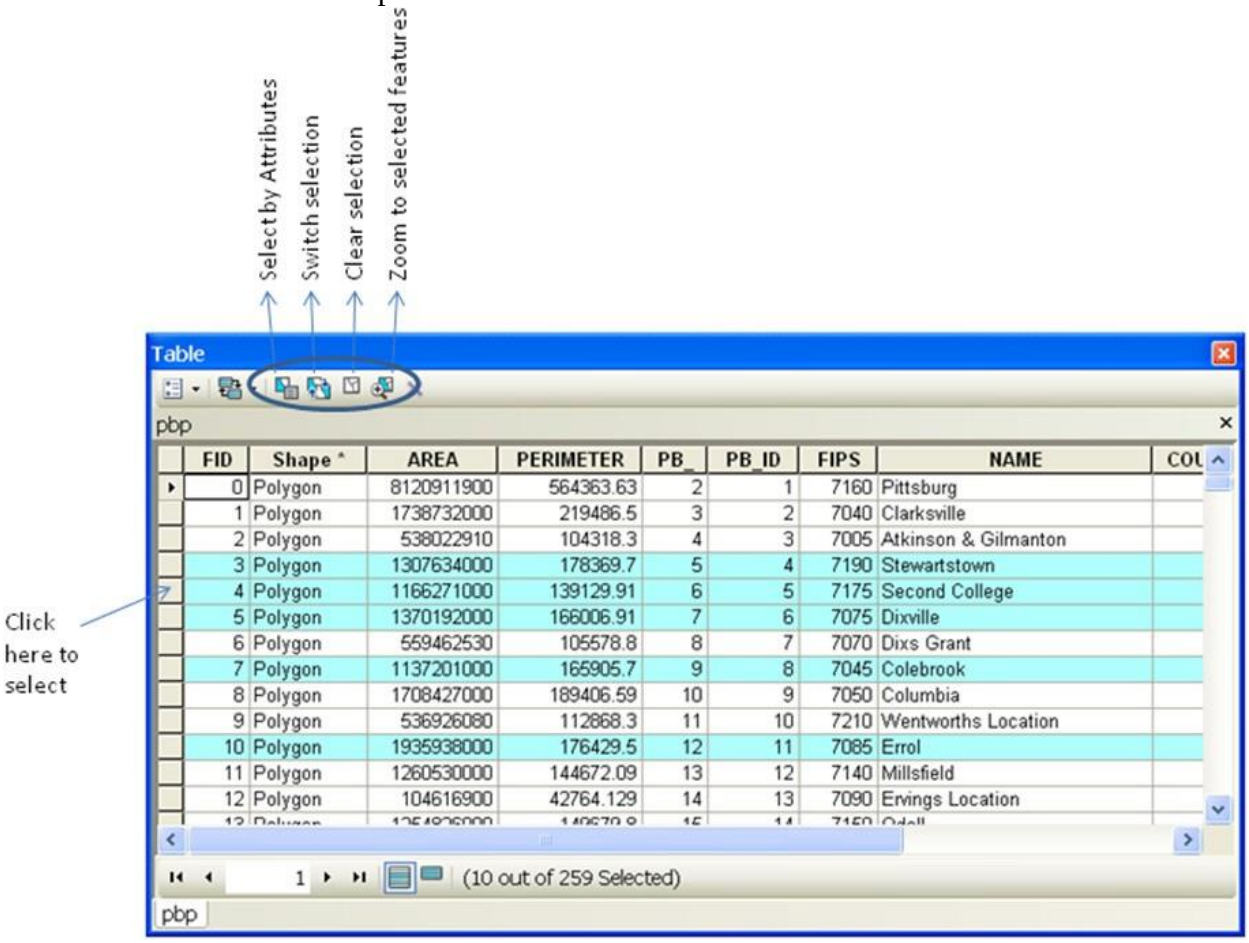


Click the 4th icon from the left at the top of the TABLE OF CONTENTS – the List By Selection tab.

The "regular" TABLE OF CONTENTS view shows you which layers are visible and in what drawing order; the "List by Selection" view instead shows you which layers are able to be selected and how many features in each are currently selected.

Select features in the Attribute Table
In an attribute table, you can select features by clicking on the small gray box at the far left of a row. You can click on just one row, drag down for several rows, or hold down the Ctrl key to select multiple rows.

Experiment with selecting towns by clicking on the gray box at the left. You can clear your selection by clicking the gray box in the very upper left hand corner, or by clicking the CLEAR SELECTION button at the top of the table.



FID	Shape *	AREA	PERIMETER	PB_	PB_ID	FIPS	NAME	COU
0	Polygon	8120911900	564363.63	2	1	7160	Pittsburg	
1	Polygon	1738732000	219486.5	3	2	7040	Clarksville	
2	Polygon	538022910	104318.3	4	3	7005	Atkinson & Gilmanton	
3	Polygon	1307634000	178369.7	5	4	7190	Stewartstown	
4	Polygon	1166271000	139129.91	6	5	7175	Second College	
5	Polygon	1370192000	166006.91	7	6	7075	Dixville	
6	Polygon	559462530	105578.8	8	7	7070	Dixs Grant	
7	Polygon	1137201000	165905.7	9	8	7045	Colebrook	
8	Polygon	1708427000	189406.59	10	9	7050	Columbia	
9	Polygon	536926080	112868.3	11	10	7210	Wentworths Location	
10	Polygon	1935938000	176429.5	12	11	7085	Errol	
11	Polygon	1260530000	144672.09	13	12	7140	Millsfield	
12	Polygon	104616900	42764.129	14	13	7090	Ervings Location	

Select By Attributes

The Select by Attributes dialogue lets you write a query to select features based on the values in the attribute table.

Click the SELECT BY ATTRIBUTES button at the top of the table window.

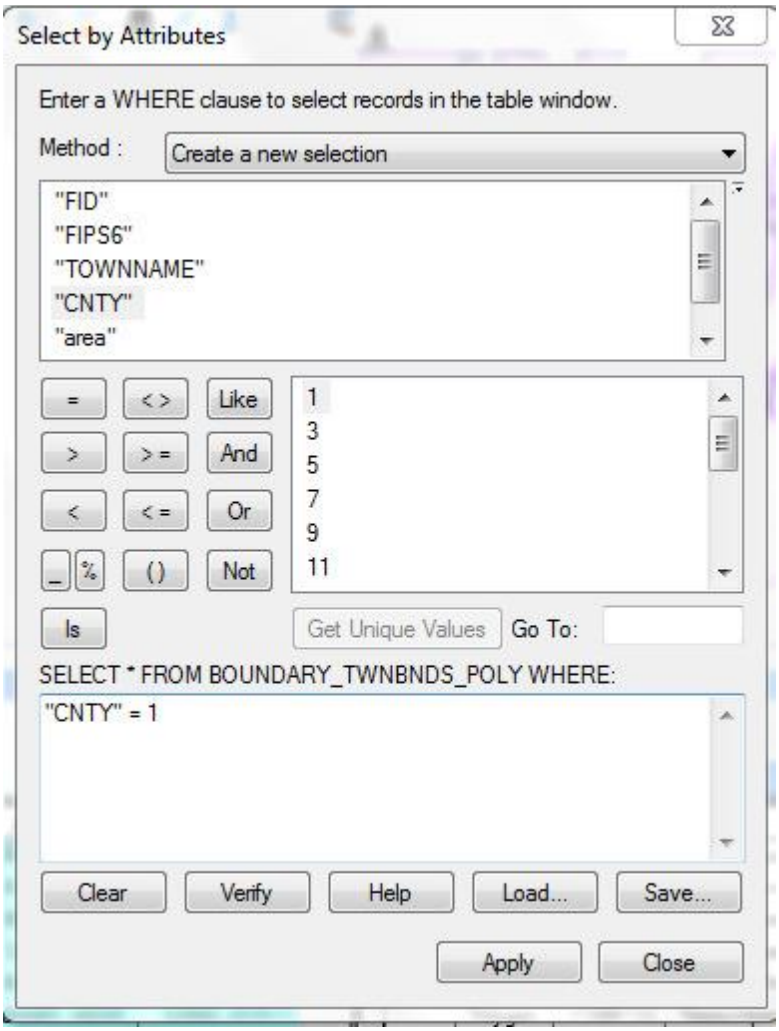
Select all of Addison County by the following steps:

i. Double click on the field “CNTY”
ii. Single click on the = operator
iii. Click the GET UNIQUE VALUES button
iv. Double click on the number 1 (for Addison County)

Your statement should read: SELECT * FROM Boundary_TWNBNDS WHERE: "CNTY" = 1
(Note that by clicking on the options as instructed above, you avoid having to know

whether/where to use single quotes/double quotes, etc. You are much better off doing it this way than trying to type the statement in the dialog window!)

Click APPLY, then CLOSE. All of the towns in Addison County should now be selected.
For more guidance on writing selection queries, click the HELP button in the SELECT BY ATTRIBUTES dialog. ArcGIS's Help is actually remarkably helpful, and frequently gives very useful examples. Queries can be more complex than the ones we use here – combining multiple expressions, incorporating wild- cards, involving calculations, and so on. The help text gives many examples that may be quite useful to you.



Labeling features:

Generally, labeling is the process of placing descriptive text onto or next to features on a map. In ArcGIS, labeling refers specifically to the process of automatically generating and placing descriptive text for map features. A label is a piece of text on the map that is dynamically placed and whose text string is derived from one or more feature attributes.

In ArcGIS:

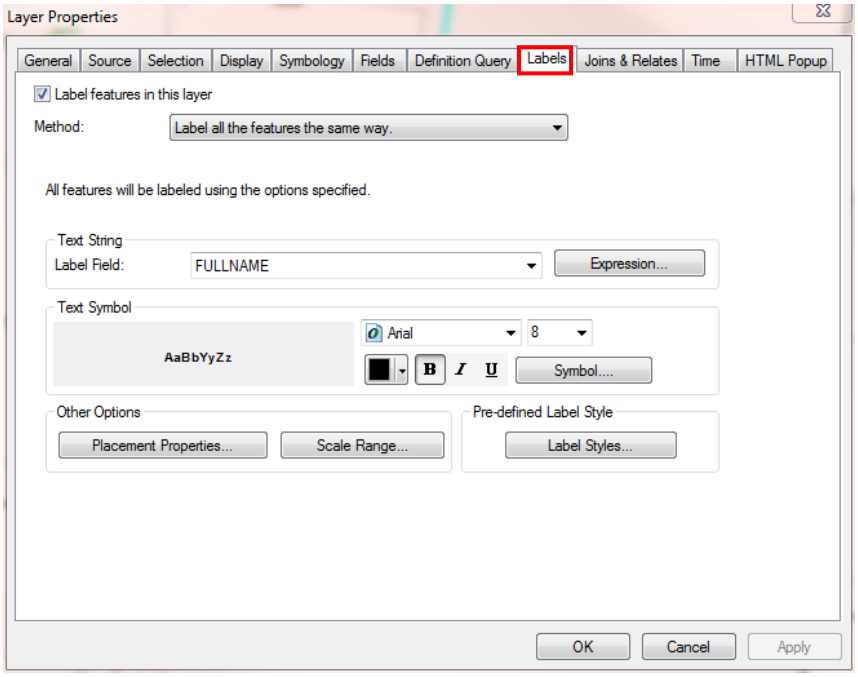
- Label positions are generated automatically.
- Labels are not selectable.
- You cannot edit the display properties of individual labels.

Labeling is useful to add descriptive text to your map for many features. Labeling can be a fast way to add text to your map, and it avoids you're having to add text for each feature manually. In addition, ArcMap labeling dynamically generates and places text for you. This can be useful if your data is expected to change or you are creating maps at different scales.

The fastest and easiest way to label your data is to right click the layer in the table of contents and select label features. The process with label the data based on data that is in the attribute table.

The change the information used to label your data:

1. Right click on the layer in the table of contents.
2. Select properties
3. Select the Labels Tab
4. From here you can change how features are layered using the Label Field box

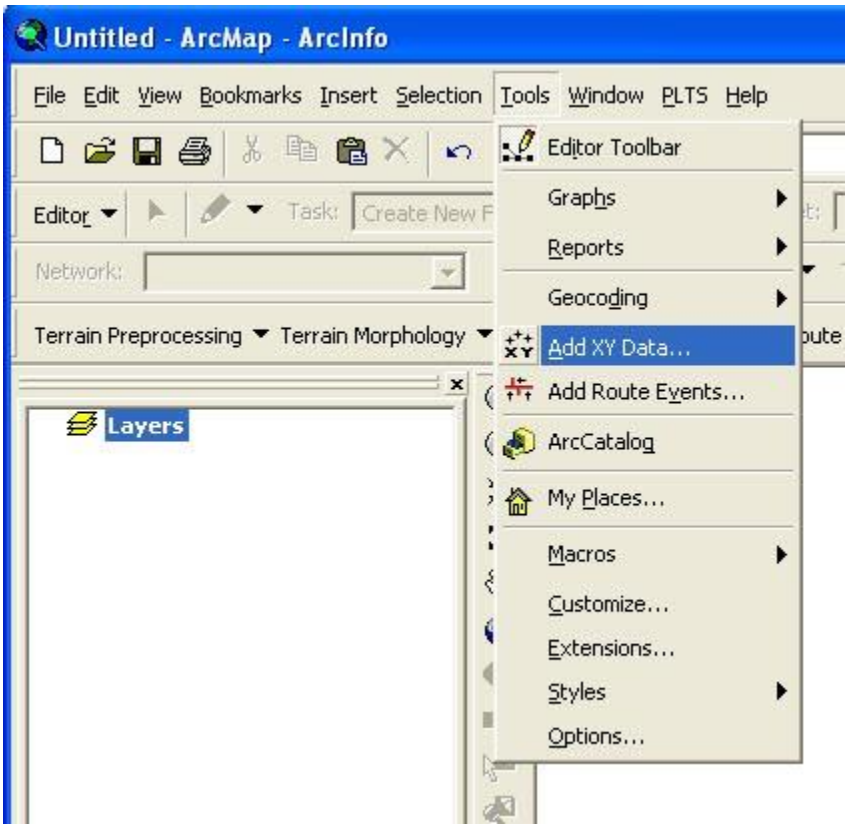


Adding X/Y data from a table:

In addition to data sources, such as a shapefile, you can also add tabular data that contains geographic locations in the form of X, Y coordinates to your map.

X, Y coordinates describe discrete locations on the earth's surface such as the location of fire hydrants in a city or the points where soil samples were collected. You can easily collect X, Y coordinate data using a global positioning system (GPS) device.

To add a table of X, Y coordinates to your map, the table must contain two fields, one for the x-coordinate and one for the y-coordinate. The values in the fields may represent any coordinate system and units such as latitude and longitude or meters.



In *ArcMap*:

Select ***Add XY Data…*** from the *Tools* menu

In the *Add XY Data* window:

Choose a table… Browse to your X-Y data file

X Field = **<Longitude field>** (whatever your E-W field is named)

Y Field = **<Latitude field>** (whatever your N-S field is named)

For the *Spatial Reference of Input Coordinates | Description:*
(by default this will say "Unknown Coordinate System")

Click on ***Edit*** (below the *Description* box)

In the *Spatial Reference Properties* window, press ***Select***

In the *Browse for Coordinate System* window browse to the appropriate coordinate system

Coordinate System used for MCB-Quantico:

Geographic Coordinate Systems | *World* | ***WGS 1984***
Projected Coordinate Systems | *UTM* | *Nad1983* | ***NAD 1983 UTM Zone 18N***

Press ***Add***
Back in the *Spatial Reference Properties* window, press ***OK***
Back in the *Add XY Data* window, press ***OK***

Once you have added the data to your map, it becomes an XY event layer and behaves like other point feature layers. For instance, you can decide whether you want to display it, symbolize it, set the visible scale, or display a subset of features that meet some criteria.

If the table on which an XY event layer is based does not have an ObjectID field, you won't be able to perform certain tasks on the layer, this is okay because you can bring the data into your mapping session and perform the following task:

Export data to a shapefile (right-click on the X-Y data layer in the *Table of Contents* and choose ***Data*** | ***Export Data…***

In *Export Data* window:
Check *Use the same Coordinate System as* ***this layer's source data***
Rename and/or change the storage location of the new shapefile as desired in the *Output shapefile* box

Click ***OK***

Saving a map and exiting ArcMap:

After you finish working on a map, you can save it and exit ArcMap. You save a map as a document and store it on your hard disk. If you haven't saved the map before exiting, you'll need to name it, preferably with a name that adequately describes its contents. If using the "X" in the upper right corner of the window to exit the program, ArcMap will automatically prompt you to save your mapping document if you have not already done so.

ArcMap automatically appends a file extension (.mxd) to your map document name.

The data displayed on a map is not saved with it. Map layers reference the data sources in your GIS database. It is good practice to not move data around on your hard disc as you may disrupt the link between data that is displayed in a map (referred to as data source). If you do move data around and lose your data source connection, you can easily fix this in ArcMap.

Repairing broken links for a single layer:

If you only want to repair a broken link for one particular layer, click the Set Data Source button on the Source tab of its Layer Properties dialog box. This lets you specify the

layer's data source by browsing to it. When you click this button, ArcMap repairs only the current layer, even if the data sources of other layers that need repairing can be found in the location of the data source you specify.

The other option is to right click the data layer in the table of contents. Scroll down and select "repair data source" and identify the location of the data in the pop-up window.

1. Locate the layer with the broken link in the table of contents.
2. It will have a red exclamation mark next to it, and its check box will be unavailable.
3. Right-click the layer and click Properties.
4. Click the Source tab.
5. Click the Set Data Source button, navigate to the data source you want, and click Add.
6. Click OK.

Repairing broken links for multiple layers:

You may find that several layers in your map need repairing. For example, if a folder containing data sources that are used for multiple layers in your map has been moved or renamed; all these layers will need to be repaired. If you want to repair several layers at once, use the Repair Data Source command from the layer's context menu.

With Repair Data Source, ArcMap repairs the selected layer using the data source you browse to and also automatically repairs other broken layers if it can find their data sources in the location of the data source you specified.

1. Locate the layer with the broken link in the table of contents.
2. It will have a red exclamation mark next to it, and its check box will be unavailable.
3. Right-click the layer, point to Data, and click Repair Data Source.
4. Navigate to the data source you want and click Add.

   ArcMap repairs the layer using the data source you specified and also automatically repairs other broken layers if it can find their data sources in the location of the data source you specified.

It's always a good idea to save your map periodically while editing it.

Saving your map

1. Click the Save button  on the Standard toolbar. If you haven't saved the map before, you'll need to name it

Adding Text to a map:

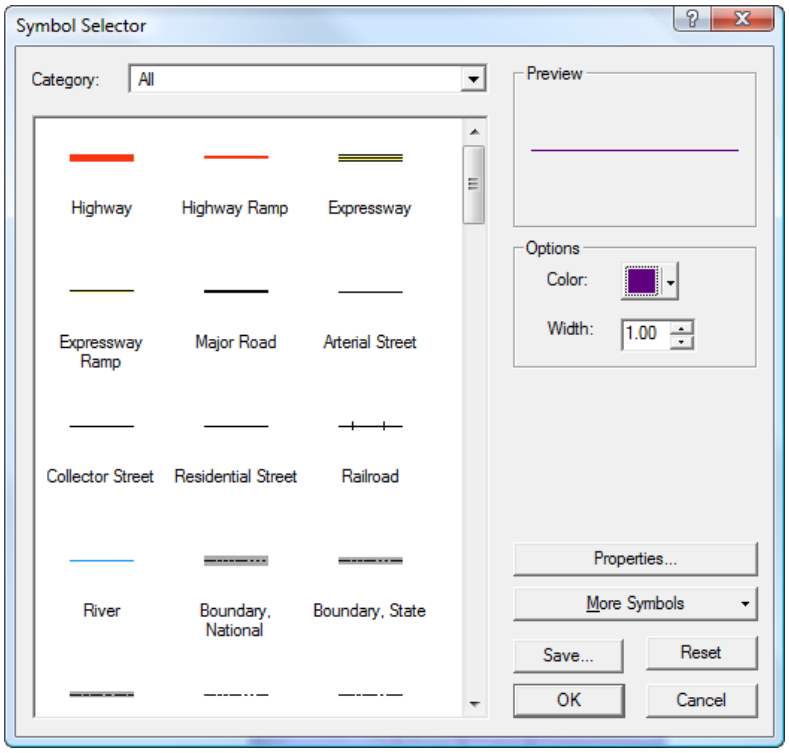
This is a process of adding text as a graphic (not the same as labeling) to your map to help provide more detail or highlight a specific area of your map. These graphics can be moved around your map and manipulated to achieve the look you are going for.

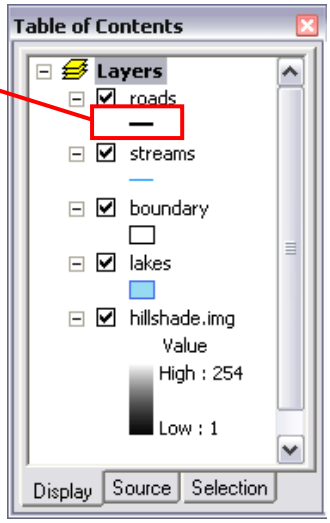
Maps convey information about geographic features, yet displaying only features on a map—even with symbols that convey their meaning—isn't always enough to make your point. Adding text to your map improves the visualization of geographic information on your map.
There are various kinds of text you can add to your map.

Descriptive text can be placed near individual map features. For example, you might add the name of each major city in Africa to your map. You can also add text to draw attention to an area of the map such as the general location of the Sahara Desert. You can also add text that improves the presentation of your map. For example, a map title provides context; you might also consider adding other information such as map author, data source, and date.

Symbology:

One of the most powerful functions in ArcMap is the ability to symbolize data in a variety of ways. Changing Symbology or changing the way a feature appears in a map can help that feature stand out or play a supporting role in your map. For example, if you don't like the symbols/colors for roads, locate the symbol below the feature heading in the table of contents and double click it. You will open the following window:





Double click the symbol below the "roads" feature heading to open the symbol selector window.

From here you can change the color, line weight, line type or create your own symbol for roads. If your map looks busy or confusing, try changing the symbology of features to highlight or mute certain features. These steps can be performed on any feature data that is in the table of contents; all points, lines, and polygons can have their symbology changed.

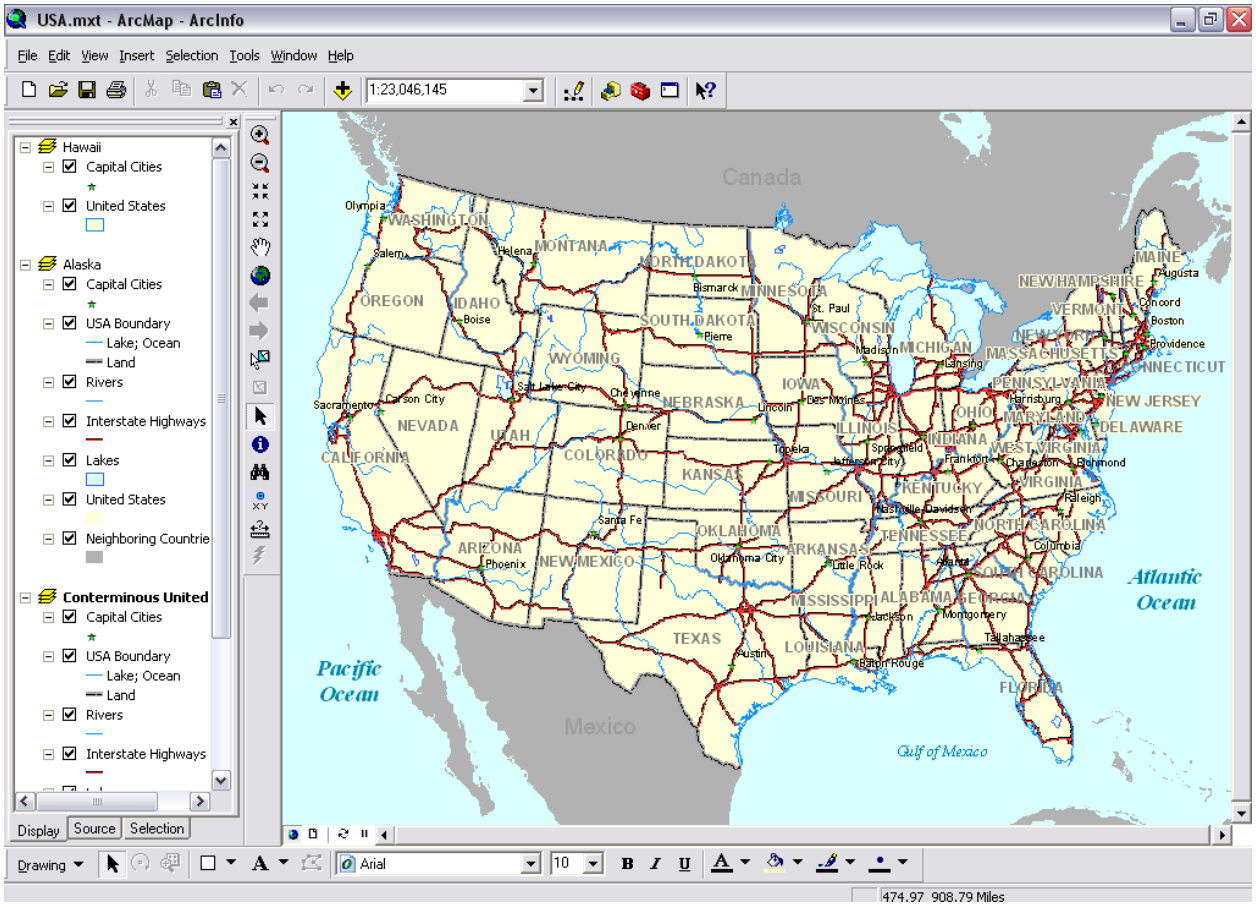
Data View and Layout View:

ArcMap provides two ways to view a map:

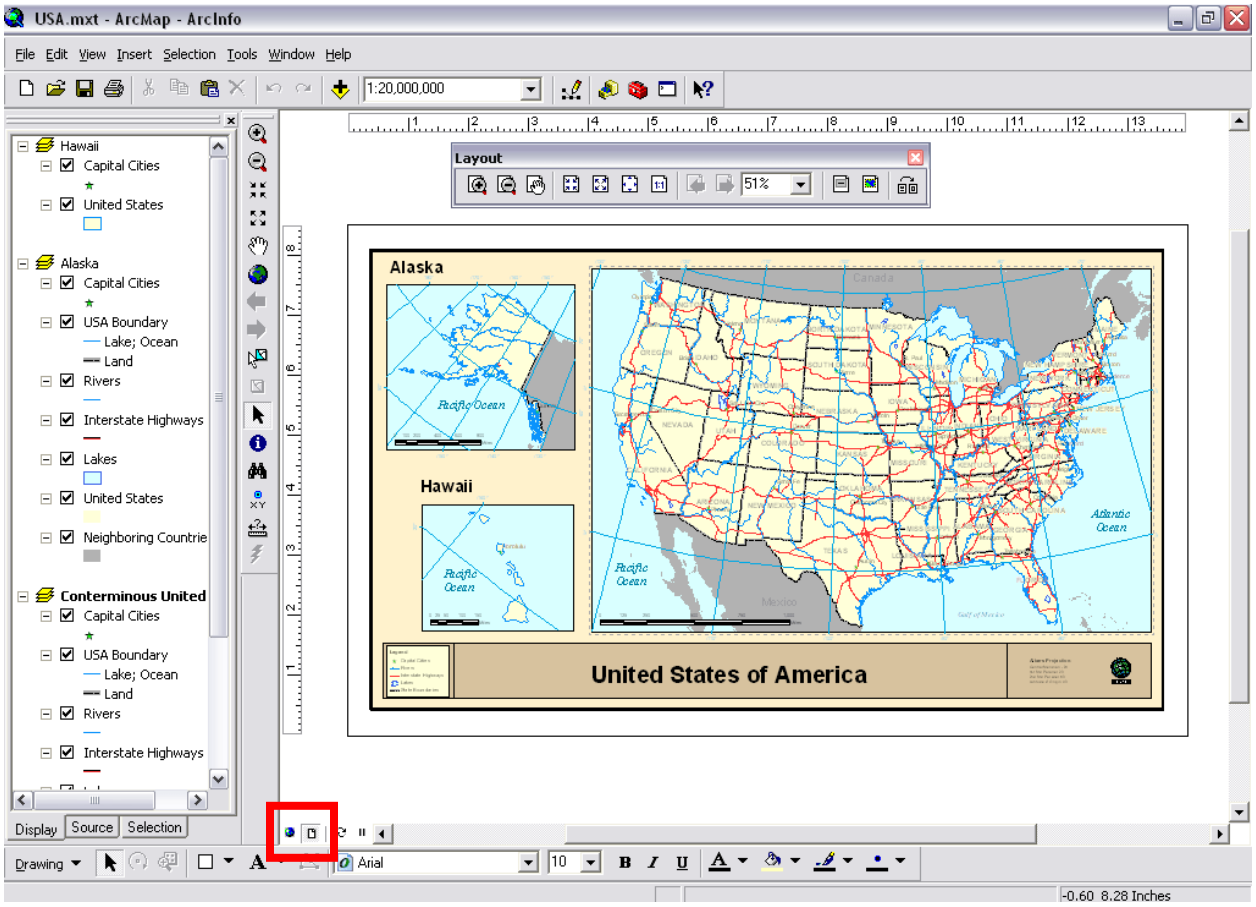
- Data view
- Layout view

Each view lets you look at and interact with the map in a specific way.

When you want to browse the geographic data on your map, choose data view. Data view is an all-purpose view for exploring, displaying, and querying the data on your map. This view hides all the map elements on the layout, such as titles, north arrows, and scale bars, and lets you focus on the data in a single data frame, for instance, editing or analysis.



When you're preparing your map's layout, you'll want to work with it in layout view. In layout view, you'll see a virtual page on which you can place and arrange map elements, and you can do almost everything you can in data view, plus design your map.



You can toggle between data and layout view easily. Simple select either the data or layout view icon on the bottom left of the work frame in either view. The red square above identifies these icons. The **data view** icon resembles an "earth" image and the **layout view** resembles a "page" icon.

The user can use the following to toggle between each view using the menu bar as well.

Switching to data view

1. Click the View menu.
2. Click Data View.

   The ArcMap window displays the active data frame

Switching to layout view

1. Click the View menu.
2. Click Layout View.

   The ArcMap window displays the entire map.

Setting Map Scale:

You can specify the scale of your map by either typing in a value or choosing one from a list. When you specify a scale, the map is zoomed to that scale.

There are many ways you can enter values into the scale box. You can simply type a number with or without comma separators, you can type a 1: and a number, you can paste values into the box, or you can type a relative scale. If you type a relative scale, for example, 1 cm = 100 m, then ArcMap will calculate an absolute scale for you.

- The "1:" prefix can be present or absent:

  1:1,000,000
  1,000,000

- Any character or word can be used as the separator in an absolute scale specification:

  1:25000
  1 - 25000
  1 to 1000
  1/1000

- Thousand separators can be present or absent:

  1,000,000
  1000000

- The values can be specified in reverse order:

  1:1,000,000
  1,000,000:1
  1 in to 5 mi
  5 mi to 1 in

- "One" can be given as a number or a word:

  1:1,000,000
  One to 1,000,000
  One inch = 5 miles

- Relative formats are supported. When relative scale formats are specified, you can use the following unit abbreviations:

  in
  pt
  ft

yd
mi
nm
mm
cm
m
km
dd
dm

- In relative formats, you can also specify units using their full name. The scale control recognizes units by the first part of their names, so it doesn't care whether unit names are in plural or not. You can type any characters after the first part of the names shown here (* = wildcard characters):

  inch*
  poin*
  feet*
  yard*
  mile*
  naut*
  mill*
  cent*
  mete*
  metr*
  kilo*
  decima*
  decime*

- In relative formats, any word or character can be used for "equals". A space isn't required between the value and the units abbreviation.

  1 in equals 500 mi
  5 inches = 500 miles
  500mi to 1in
  100 miles for 1 inch

You will see two additional options in the drop-down list when you are specifying a scale on a dialog box:

- <None>: Choose this option to clear the scale so that no scale is used. As a shortcut to choosing <None> from the list you can type "0", "none", or "<None>".

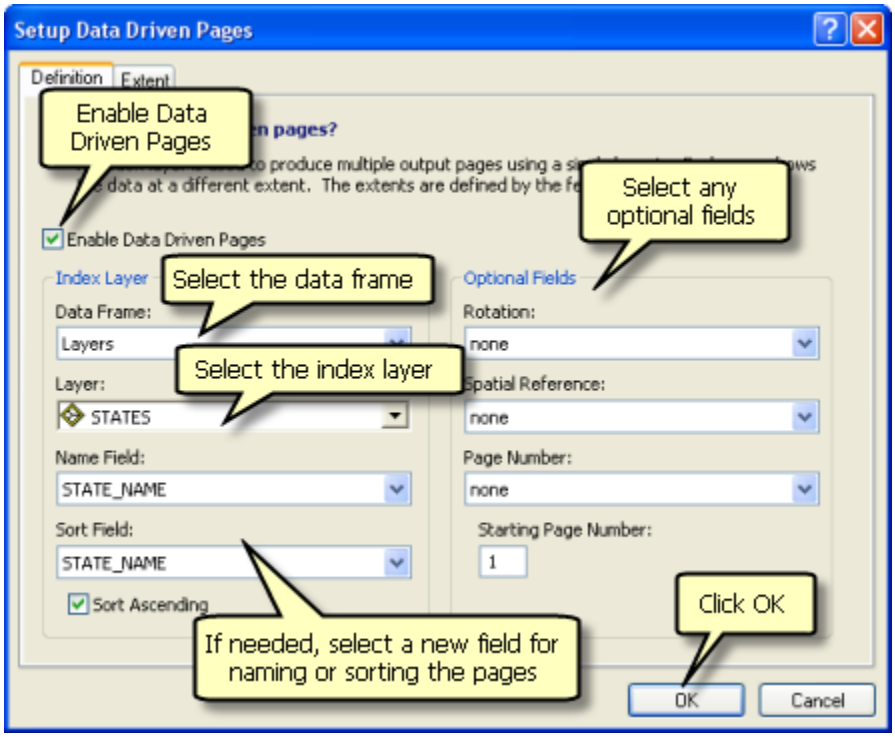
- <Use Current Scale>: If you choose this option, the current scale of the active data frame as it is displayed in the current view will be automatically inserted into the field. This makes it very easy to set the scale to be the same as the current scale you are using. So if you choose this option when the current scale of the data frame in your map is 1:45,678 that value will appear in the scale field.

Creating a Mapbook in ArcGIS 10.2:

Data Driven Pages gives you the ability to generate a set of output pages by taking a single layout and iterating over a set of map extents. The extents are defined by the features in a layer and are sometimes called tiles, sections, or areas of interest (AOI). The layer that defines the extents is referred to as an index layer. Any feature layer may serve as the index layer. You create and customize new Data Driven Pages using the ***Setup Data Driven Pages*** dialog box. This dialog box contains two tabs: **Definition** and **Extent**. You can activate this dialog box from the ***Data Driven Pages*** toolbar or from the ***Page and Print Setup*** dialog box.

Setup Data Driven Pages dialog box

Through the **Definition** tab, you can select the index layer that drives the geographic extent for each page. You can also choose fields to use to name and sort the pages. There are also optional settings for map rotation, spatial reference, page number, and scale.



Enabling Data Driven Pages

The **Enable Data Driven Pages** check box enables Data Driven Pages for the current map document. Unchecking the check box disables Data Driven Pages functionality. This check box needs to be checked to create, view, and utilize Data Driven Pages. If you disable Data Driven Pages and click **OK**, all Data Driven Pages settings you made are cleared. Data Driven Pages utilize the default settings the next time you enable Data Driven Pages for this map document.

Required elements for Data Driven Pages

Four elements are required for the creation of Data Driven Pages. They are

- Detail Data Frame
- Index Layer
- Name Field
- Sort Field

Detail Data Frame

To create a series of Data Driven Pages, select a data frame from the **Data Frame** drop-down menu. The default Data Frame for Data Driven Pages is the active data frame. Only a single data frame can be selected as the main data frame. The map extent of the main data frame changes for each page in the Data Driven Pages series. These map extents are driven by the spatial extent of features within the index layer.

This drop-down menu displays a list of data frames in the current map document. The map document may contain a single data frame or a number of data frames. Only one data frame can be selected for Data Driven Pages. This is the Detail Data Frame. You can choose any data frame in your map as the Detail Data Frame (as long as there is at least one layer in it).

Index Layer

To create a series of Data Driven Pages, select the index layer from the ***Layer*** drop-down list. The default index layer is the topmost polygon layer of the active data frame. The index layer defines the geographic extent of the main data frame for each page in the Data Driven Pages series. Each feature in the index layer drives, or defines, each page in the Data Driven Pages series. The geographic extent of the feature helps define the map extent of the Detail Data Frame for the page (this extent can be further customized on the **Extent** tab). Attributes of the index layer provide values for other Data Driven Pages parameters.

This drop-down menu displays a list of layers from Detail Data Frame. You can choose any feature layer from the Detail Data Frame for the index layer, as long as there is at least one feature in the layer. You are not confined to using only polygon layers as the index layer. You can also use points and lines, as long as you use a feature layer. Nonfeature layers, such as raster layers, cannot be used for the index layer. There are two geoprocessing tools available from the Data Driven Pages toolset in the Cartography toolbox to help you create an index layer: Grid Index Features and Strip Map Index Features.

When using point features, if you want to use only one map scale for each page, choose the **Center and Maintain Current Scale** option. Then, after exiting the ***Setup Data Driven Pages*** dialog box, set the scale of the Detail Data Frame to the scale you want. If you want different scales for different point features, you need to use a field containing these values and select **Data Driven Scale**on the **Extent** tab and choose this field. You cannot use a layer from another data frame, another map document, or a stand-alone layer file (.lyr) as an index layer. The index layer must be a feature layer. You cannot use raster-based layers as the index layer.

You should see a message box when creating Data Driven Pages and the index layer has more than 2,000 features. You can still create the pages, but be aware that performance may be adversely affected when dealing with such a large number of pages.

You may want to label adjacent grids on your layout. In a map book, this would be the same as labeling adjacent, or neighboring, pages. Using dynamic text, you can navigate through the pages of your map book and have the labels identifying neighboring pages update automatically. You can use the geoprocessing Calculate Adjacent Fields tool to create the data you can use to label adjacent pages.

Name Field

Each page in the map series needs a name, and the names are taken from this field. As Data Driven Pages iterates through the features in the index layer and each page is defined, the attribute value for the chosen name field is used as the page name.

The page name can be displayed on the ***Data Driven Pages*** toolbar. This can also drive a dynamic text element in the layout. You can add dynamic text for the page name using the **Page Text**menu item on the ***Data Driven Pages*** toolbar. Use the **Page Name** option. Or, you can apply the formatting tag <dyn type="page" property="page name"/> to an existing text element.
Select the Name Field from the list in the **Name Field** drop-down menu. The default is the first field using the string "name" in the field name. If there is no field using "name" in the field name, Data Driven Pages will then use the first available valid field. You do not have to use the default. You can choose to use a different field by selecting it from the drop-down menu.

This drop-down menu displays a list of applicable fields from the index layer. This list includes fields from a table joined to the index layer. These include short integer, long integer, and string.

To avoid confusion when working with Data Driven Pages, you should choose a Name field in which all values are unique. However, this is not required, and Data Driven Pages will accept null and duplicate values for Page names.

Sort Field

Pages in the map series need to be sorted. There needs to be a first page, a last page, and all the pages in between. The sort field provides the sorting logic and index for the pages. The first page of the series, or page 1, is determined based on the values of this field and whether the sort is in ascending order or not. The index always starts with 1 and ends with the number of pages created. This index changes when you change the sort field or refresh the pages after editing the sort field values.

Since sort order is required for Data Driven Pages to work, a default field is chosen each time a new index layer is selected. The default is the first field using the string "PageNumber" in the field name. In many cases, you may want to apply your own page number values. Often, these values also match the order in which you want to sort your pages. Again, these values may or may not match the page index number. If there is no field using "PageNumber" in the field name, Data Driven Pages will then use FID or ObjectID.

You do not have to use the default. You can choose to use a different field by selecting from the drop-down menu. The drop-down menu displays a list of applicable fields from the index layer. This list includes fields from a table joined to the index layer. These include short integer, long integer, float, double, date, and string.

The page index can be displayed on the ***Data Driven Pages*** toolbar. For example, you might see "14 of 20". This means you are looking at the 14th page of 20 pages. This can also drive a dynamic text element in the layout. You can add dynamic text for the page index using the **Page Text** drop-down menu on the ***Data Driven Pages*** toolbar. Use the **Page with Count** option. Or, you can apply the formatting tag Page <dyn typePage Text="page" property="page index"/> or <dyn type="page" property="page count"/> to an existing text element.

Page index is also reflected in the export dialog box. When you export Data Driven Pages using a page range, you are exporting pages based on their location in the index. The page index may or may not be the same number as the page number. The page index is internally generated, always begins with 1, and ends with the total number of pages. Page numbers can be alphanumeric, begin after 1, and end with a number greater than the total number of pages (this might be done to account for inserted pages in the final product).

Data Driven Pages will accept null and duplicate values in the Sort field, but you should try to avoid this whenever possible.

Optional Fields

The Data Driven Pages setup provides three optional fields that you can use to further customize your pages. These fields must be an attribute of the index layer or field from a table that is joined to the index layer. They are

- Rotation
- Spatial Reference
- Page Number

Rotation

There are some use cases where you want to apply a map rotation to specific pages or all pages in your map series. For example, a common type of map series or map book that requires map rotation is a strip map. A strip map often follows a linear feature. To make such a map series more readable, the map's page orientation is such that the linear feature draws from top to bottom and is centered on the page. This requires that the data frame be rotated. Though you can use any numerical index layer field to apply rotations to Data Driven Pages, you may want to consider using the Strip Map Index Features geoprocessing tool to create an appropriate index layer. This tool creates a new index layer that contains a field with appropriately calculated values for rotation based on your input.

Add this new layer to your map document and use it as the index layer for the Data Driven Pages. Select the appropriate field as the rotation field. As Data Driven Pages iterates through each page, an appropriate map rotation is applied to the Detail Data Frame based on the values of this field. If the value is null, Data Driven Pages uses a value of 0. Map rotation moves in a counterclockwise direction. If the value is negative, the rotation is clockwise.

If you do not want to apply different map rotations to your pages, or want to use only the rotation value specified on the **General** tab of the ***Data Frame Properties*** dialog box (for the main data frame), do not specify this field.
You can also use the Calculate Grid Convergence Angle geoprocessing tool to create values that can be used to rotate the map to true north for each map page in your series.

This drop-down menu displays a list of applicable fields from the index layer. This list includes fields from a table joined to the index layer. These include short integer, long integer, float, and double.

Spatial Reference

There may be cases where you want to use specific spatial references for specific pages in your map series. You have three different ways to apply spatial references in Data Driven Pages. One way is to use the entire spatial reference string. This way, you can customize spatial reference parameters as you see fit.

Here is an example of a spatial reference string for geographic coordinate system WGS 1984:

GEOGCS["GCS_WGS_1984",DATUM["D_WGS_1984",SPHEROID["WGS_1984",6378137,298.257223563]],PRIMEM["Greenwich",0],UNIT["Degree",0.0174532925199433]]

A drawback to using the spatial reference string is that it can be very long and cumbersome. It is too large to store in a shapefile. Another way to apply spatial references is to point to a projection file on disk, if you have one. This can be a file local to your machine or a file on a network. You need to have the proper permission to these files.

Here is an example of the path to the WGS 1984 projection file:

C:\MyProjectionFiles\WGS 1984.prj.

The last way to apply spatial reference is to use factory codes. A factory code is an integer identifier that is unique by coordinate system. Custom coordinate systems have a factory code of 0. Factory codes can be stored as either short or long integers.

The factory code for geographic coordinate system WGS 1984 is 4326.

When you specify a Spatial Reference field, values from this field define the spatial reference of the main data frame for each page in the Data Driven Pages series. If the value in this field is null, incomplete, or otherwise unusable, Data Driven Pages ignore the field and apply the last spatial reference used to the current page.

There are two geoprocessing tools available from the Data Driven Pages toolset in the Cartography toolbox to help you populate a spatial reference field: Calculate Central Meridian and Parallels and Calculate UTM Zone.
If you do not want to apply different spatial references to your pages, or want to use only the spatial reference specified on the **General** tab of the ***Data Frame Properties*** dialog box (for the main data frame), do not specify this field.

This drop-down menu displays a list of applicable fields from the Index Layer. This list includes fields from a table joined to the Index Layer. These include short integer, long integer, and text.

Caution:

If you select a field for Spatial Reference, create Data Driven Pages (by clicking **OK**) then decide you do not want to use the field to drive spatial references, you cannot simply choose none from the drop-down list to go back to a default spatial reference. There is no default spatial reference. Data Driven Pages always uses the last valid spatial reference if one is not supplied. You must manually change the spatial reference to get the data frame back to the one you want.

Page Number

Data Driven Pages also allows you to define a page number. The page number can be based on field values of the index layer. These values can be alphanumeric. For example, you can use Roman numerals or numbers with dashes to number your pages. If you are inserting pages between maps, you may be skipping page numbers as you populate this field.

These page number field values can be used to drive dynamic text in the map layout. You can add dynamic text for the page index using the **Page Text** drop-down list on the ***Data Driven Pages***toolbar. Use the **Page Number** option. Or, you can apply the formatting tag Page <dyn type="page" property="page number"/> to an existing text element.

Page number may or may not be the same as page index. In many cases, you will want the first map in your map book to be on the page after page 1. You may also want gaps in the page numbering to allow for inserted pages.

For example, suppose you are designing a map book where there will be pages for 10 map features. You want the map book to include a title page, a table of contents, and an overview map, and you want tabular information to be inserted between each map page. You need to incorporate a number of files to get this final product. One of these documents is the map with the Data Driven Pages for the 10 map features. To account for the anticipated pages at the beginning of the map book and the inserted page between each map page, add a Page Number field to the index layer and populate the field as follows (the features have already been sorted accordingly).

Page number
Page 4
Page 6
Page 8
Page 10
Page 12
Page 14

Page 16
Page 18
Page 20
Page 22

You select this field from the page number drop-down list and create your data driven pages. Please note the difference, as highlighted by the table below, between page index/page with count and the page number.

Page index	Page number	Page with count
1	Page 4	1 of 10
2	Page 6	2 of 10
3	Page 8	3 of 10
4	Page 10	4 of 10
5	Page 12	5 of 10
6	Page 14	6 of 10
7	Page 16	7 of 10
8	Page 18	8 of 10
9	Page 20	9 of 10
10	Page 22	10 of 10

This is an optional field. The drop-down menu is filtered to display applicable field types. This list includes fields from a table joined to the index layer. These include short integer, long integer, double, and text.

Page numbers should be unique, though Data Driven Pages accepts null and duplicate values.

Starting page number

In some cases, you may want to start the map series pages at a page other than the first page. For example, you may want the first three pages in your map book to be for a title, a table of

contents, and an overview map. The maps (the results of the Data Driven Pages PDF export) actually begin on page four. You enter 4 in the **Starting Page Number** text box on the ***Data Driven Pages Setup*** dialog box. If you have a dynamic text element for page numbers in your layout, you should see Page 4 displayed for the first map page. Remember, since this is the first map, the index number for this page is 1. If you wanted to export only this page, you would use 1 to identify the page in the **Page Range** text box even though the page number is 4.

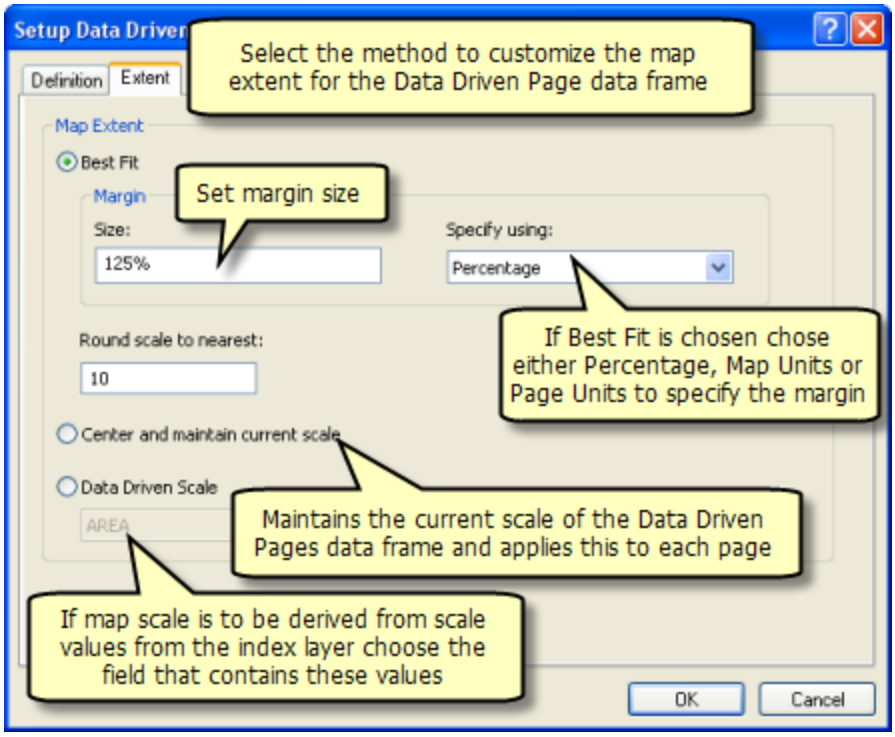
Here is a breakdown of page index, page number (dynamic text), and page number with count (dynamic text) for a map series of 10 maps and the starting page number set at 4.

Page index	Page number	Page with count
1	Page 4	1 of 10
2	Page 6	2 of 10
3	Page 8	3 of 10
4	Page 10	4 of 10
5	Page 12	5 of 10
6	Page 14	6 of 10
7	Page 16	7 of 10
8	Page 18	8 of 10
9	Page 20	9 of 10
10	Page 22	10 of 10

This option is only valid when page numbers are calculated internally. It is not valid when a page number field has been specified.

Optional settings (Map Extent)

The **Extent** tab allows you to define the margin between the edges of the data frame and the index feature for each page. There are three options: **Best Fit**, **Center and maintain current scale**, and **Data Driven Scale**.



Best Fit

The **Best Fit** option provides a margin, measured along the horizontal or the vertical axis, between the edge of the data frame and the closet point of the index feature. The location of this closest point determines whether the margin is measured along the horizontal or the vertical. Other points of measurement may be larger than the specified fit. This is especially true for index features that are geometrically asymmetric or irregular. This is expected.

A margin can be specified as a percentage, in map units, or in page units.

A percentage value of 100 percent places the closest point of the index feature adjacent to the edge of the data frame. Values greater than 100 percent result in a margin between the feature and the data frame edge. The size, or distance, between data frame edges is calculated as a percentage of the distance, in map units, of the axis containing the closest point. For example, the closest point is along the vertical axis. The longest vertical length of the feature is 150 km. A margin percentage value set at 110 percent results in a data frame of (150 km * 110%) = 165 km, with a margin of 7.5 km on either side. Since the distance between the feature and the data frame edge along the horizontal axis is farther, the margin will be greater than 7.5 km. Values less than 100 percent shrink the data frame to an extent that is within the extent of the index feature.

Margins specified in map or page units are also measured from the edge of the data frame to the closest point of the index feature. Unlike percentage, the size value is applied to each side of the horizontal axis or the vertical axis. For example, a margin is set at 50 km. The closest point of the index feature is along the vertical axis. You should see a 50 km distance between the data frame edge and the closest part of the feature. At the other end of the axis, and along the horizontal, you will see margins greater than 50 km. You will see similar results if you choose page units to measure the margin.

Center and maintain current scale

By choosing the **Center and maintain current scale** option, the detail data frame for each page in the Data Driven Pages series is centered on the center of the index feature and maintains a constant map scale. The map scale is set in the **Scale** text box on the ***Standard*** toolbar.

Data Driven Scale

By choosing the **Data Driven Scale** option, the map scale of the detail data frame for each page in the Data Driven Pages series is data driven. Use the drop-down list to select an appropriate field containing the data you want to use to determine scale. The drop-down list is filtered to display applicable field types. These include short integer, long integer, float, and double.

When you specify a Data Driven Scale field, values from this field define the map scale of the detail data frame for each page in the Data Driven Pages series. If a value is null, Data Driven Pages uses the scale value of the previous page. Any fixed scale or a fixed extent associated with the detail data frame is ignored when Data Driven Pages are enabled.

Data Driven Pages Defaults

- **Data Frame—**The active data frame is used as the default data frame.
- **Index Layer—**The topmost polygon layer of the active data frame is used as the default index layer.
- **Name Field—**The first index layer field using the string "name" in the field name is used as the default name field. If there is no field using "name" in the field name, Data Driven Pages then uses the first available valid field. Valid field types for the name field include text, short integer, and long integer.
- **Sort Field—**The first index layer field using the string "pagenumber" in the field name is used as the default sort field. If there is no field using "pagenumber" in the field name, Data Driven Pages then uses FID or ObjectId.
- **Optional Fields—**None.
- **Map Extent—Best Fit** option at 125%.

How to create Data Driven Pages

These steps assume that you already have an index layer with all the needed fields for customizing the pages. If you need to create an index layer or create data in the index layer for the customizations described above, you can use geoprocessing tools from the Data Driven Pages toolset.

First, you should add the ***Data Driven Pages*** toolbar. The toolbar gives you access to the ***Setup Data Driven Pages*** dialog box, which you use to create your pages. You can also use the toolbar to navigate and refresh the pages, along with adding dynamic text for the page name or the page number.

Adding the Data Driven Pages toolbar

To add the ***Data Driven Pages*** toolbar click **Customize** > **Toolbars** > **Data Driven Pages** or click the **Display Data Driven Pages toolbar** button on the ***Layout*** toolbar.

Creating Data Driven Pages

1. Click the **Setup Data Driven Pages** button on the ***Data Driven Pages*** toolbar.
2. Click the **Definition** tab.
3. Check the **Enable Data Driven Pages** check box.
4. Check the default for **Data Frame**. If this is not the data frame you want as the main data frame for the Data Driven Pages, choose a different data frame from the drop-down menu.
5. Check the default for **Layer**. If this is not the layer you want to use as the Index Layer, choose a different layer from the drop-down menu.
6. Check the default for the **Name Field**. If this is not the field you want to use to name your page, then choose a different field from the drop-down menu.
7. Check the default for the **Sort Field**. If this is not the field you want use to sort your pages, then from choose a different field from the drop-down menu.
8. Select a field for **Rotation** if you want to apply a rotation to each page. Otherwise, you can leave the default value of none.
9. Select a field for **Spatial Reference** if you want to apply a rotation to each page. Otherwise, you can leave the default value of none.
10. Check the default for **Page Number**. If this is not the field you want to use to get the page number for each page, then choose a different field from the drop-down menu. Alternatively, choosing no field for page number will result with page numbers automatically generated from the **Starting Page Number** value.
11. Click the **Extent** tab.
12. Choose the extent option that you want to use.
13. Click **OK**.

Adding Page Name as dynamic text

1. Click the **Layout View** button to make sure ArcMap is in Layout view.
   Note: Dynamic text only works in Layout view.
2. Click the **Page Text** drop-down menu on the ***Data Driven Pages*** toolbar.
3. Choose **Page Name** from the list.
4. Select the newly added text element and move it to the location you want it on the page layout.

Adding Page Number as dynamic text

1. Click the **Layout View** button to make sure ArcMap is in Layout view.
   Note: Dynamic text only works in Layout view.
2. Click the **Page Text** drop-down menu on the ***Data Driven Pages*** toolbar.
3. Choose **Page Number** from the list.
4. Select the newly added text element and move it to the location you want it on the page layout.

Adding a dynamic text element for Page Number with Count (total pages)

1. Click the **Layout View** button to make sure ArcMap is in Layout view.
   Note: Dynamic text only works in Layout view.
2. Click the **Page Text** drop-down menu on the ***Data Driven Pages*** toolbar.

3. Choose **Page with Count** from the list.
4. Select the newly added text element and move it to the location you want it on the page layout.

The section below will cover some of the more advanced geoprocessing features that ArcGIS has to offer that have yet to be covered in this training guide.

How to create a street index:

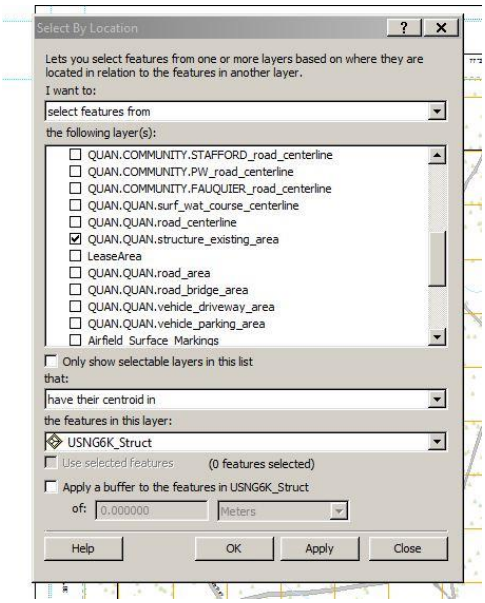
A street index is an extremely important part of the mapbook. It helps the reader quickly identify page(s) that pertain to the purpose of their search. In this portion of the training guide, I am going to walk you through a step-by-step process used to create a street index using only the data encompassed by your grid reference as well as how to associate those attributes to your index.

For this example we will use structures and their associative data to create the index. The end product should display building number, building name, and street address, coordinate address (grid based street address - optional), page number, and USNG page number in the index.

Below I give a couple of examples of how to generate a street index using data driven pages and a spatial join.

To accomplish this task we first want to limit our coverage area to only the grid squares that have structure data in them. To accomplish this we will perform a select by selection analysis.

1.) Select the **Selection** tab from the tool bar
2.) Click on **Select by Location**
3.) When the window opens, file the form out to display:
    a. Select features from existing structure area
    b. That have their centroid in
    c. USNG_6K



Now that all the grid squares containing structure data are selected, we want to create a layer from selected features to isolate this grid.

4.) Create a layer from selected features

a.

1. Intersect the streets feature class with the map grid index feature class using the **spatial join** tool.
2. Use the **streets layer** as the Target Features and the **map grid index layer** as the Join Features. Set the Join Operation to One-to-Many. Leave the rest of the options as default. A new feature class is created.
3. Open the new feature class' attribute table and add a new text field.
4. Concatenate the Street Name and the PageNumber fields (Field Calculate using [NAME]& "-"& [PageNumber]).
5. **Summarize** based on the new field. (In the open attribute table, right click the concatenated field and select Summarize.) Doing this removes the duplicate entries. Select any other summarizations that might be helpful.
6. Open the created dbf file in Excel and make changes as needed. Print or convert this table to the desired format and add it to the Map Book.

Definitions:

Absolute accuracy: exact correspondence between the location of features in map data and their actual positions on the earth.

Attribute accuracy: the difference between information recorded as digital map data or database tables and the real-world features represented. For example, for map data that includes street names as attributes, the percentage of correct names would be the measure of accuracy.

Attribute information: descriptive, non-graphic information recorded as digital map data or an associated database table. Examples of attributes are street names, street types (highway, side street, etc.), and pavement types.

Cell: individual picture elements in a raster image.

Complete/Completeness: a measurement of whether map data includes the features a user would expect to be represented.

Control points: exact positions of often-surveyed geographic features used to register map sheets and transform coordinates.

Currency: measures how recently the map data was collected, usually expressed the revision date.

Data creators: companies that develop their own or enhance existing geographic data.

Data integrators: companies that gather digital map
data from a variety of public or private sources and adapt it for a specific mapping project and target software.

Data packagers: companies that repackage existing map data, with very little customization, for mass distribution.

Datum: a mathematical model that provides a smooth approximation of the earth's surface.

Digital Chart of the World (DCW): a digital database published by the US Defense Mapping Agency that contains maps of the entire world, input at a scale of 1:1,000,000.

Digital elevation models (DEMs): a representation of the terrain in a given area, expressed as a rectangular array of regularly spaced elevation values. Also referred to as a Digital Terrain Model (DTM), or Digital Terrain Elevation Data (DTED).

Digitizing: the process of converting existing data from paper maps-as well as drawings and aerial photos into digital form by (1) manually tracing the maps on hardware that consists of a digitizer tables and a cursor with crosshairs and keys used to record map features as X,Y coordinates or (2) scanning the map and using automatic conversion software to translate the resulting raster file to vectors and storing it directly in the GIS.

Display information: information that describes how digital map features will appear visually. Display information includes color, fill pattern, line type, and so on.

Easting: the east-west, X, coordinate in a rectangular coordinate system.

Feature Class - a collection of geographic features with the same geometry type (such as point, line, or polygon), the same attributes, and the same spatial reference. Feature classes can be stored in geodatabases, shapefiles, coverages, or other data formats. Feature classes allow homogeneous features to be grouped into a single unit for data storage purposes. For example, highways, primary roads, and secondary roads can be grouped into a line feature class named "roads." In a geodatabase, feature classes can also store annotation (label information) and dimensions.

File format: the physical arrangement of digital data stored in a map file.

Geodatabase - is the common data storage and management framework for ArcGIS. It combines "geo" (spatial data) with "database" (data repository) to create a central data repository for spatial data storage and management.

Geographic coordinate system: a system of numeric coordinates used to locate and record specific positions on the earth's surface.

Geographic information: information in a digital map that records the physical position and shape of a map feature.

GIS (geographic information system): a computer-based technology for retreiving, storing, and organizing data based on its location on a map.

Global Positioning System (GPS): satellite-based positioning technology that, with differential correction, can yield engineering-level accuracy.

Hierarchical: a logical structure that classifies information in a series of steps, starting with broad, simple classifications, and proceeding, in stages, to narrow, precise classifications.

Hydrography: map data that describes the positions and characteristics of bodies of water.

Hypsography: map data that describes the exact shape of the earth's surface, usually in the form of contour lines, digital elevation models, or color shadings.

Internal file format: the binary file format used internally by a specific GIS platform.

Latitude: the first component of a spherical coordinate system used to record positions on the earth's surface. Latitude indicates the angular distance north of south of the earth's equator measured through 90 degrees (see "Longitude").

Layers: a means of organizing and managing map data by type. Hydrological features (such as floodplains), parcel maps, railroads, and so on can be contained on separate layers for easy map creation and maintenance.

Local Coordinate System: a system designed for a small geographic area. Local coordinate systems cannot be expanded to include large areas without loss of accuracy. Typically, local coordinate systems are not projected systems; they are X,Y-coordinate systems (e.g., State Plane Coordinate System).

Longitude: the second component of a spherical coordinate system used to record east-west positions on the earth's surface, measured in degrees as the arc or position of the earth's equator intersected between the meridian of a given place and the prime meridian, which runs through Greenwich, England. (See "Latitude")

Mercator projection: a map projection designed by Gerhardus Mercator, where the earth's surface is drawn as it would appear if projected on a cylinder wrapped around the earth.

Metadata: information describing a data set. A digital map's metadata might state its scale, revision date, author, accuracy standards, and other pertinent information.

Northing: the north-south, Y, coordinate in a rectangular coordinate system.

Paper coordinates: coordinates measured directly from the paper on which a map is drawn, often recorded in inches or centimeters.
Planar coordinate system: a coordinate system drawn on a flat surface, or plane. Planar coordinates are usually expressed as pairs of rectangular X, Y values.

Prime meridian: the line of longitude that runs through Greenwich, England, used as the origin (zero point) for longitudinal measurements.

Projection: a system to portray all or part of the earth, which is an irregular sphere, on a planar, or flat, surface.

Raster: raster data takes an evenly spaced grid (like a piece of graph paper) and places a value in each square, or cell. Raster data is best suited for continuous data such as slope, rainfall, or the amount of light reflecting off the ground (as in a photograph).

Rectification: the process of assigning spatial coordinates to a map data image by warping it to fit known geographic control points.

Relative accuracy: the difference between how features on a map and those same features in the real world are positioned in relationship to each other. A measurement system may employ a "bias" or "systematic" error, with consequently inaccurate results, but still preserve local relationships.

Remote-sensing data: digital data collected by satellite and other airborne, electronic-[A1] imaging systems.

Resolution: the minimum distance that can be recorded by a measurement system. For example, if a map has a resolution of 10 meters, the map cannot accurately depict features smaller than 10 meters. Therefore, these features may be depicted as points, or they may not be depicted at all.

Rubber sheeting: an editing method that corrects errors by stretching maps to fit known control points.

Scale: the proportion or ratio between a map measurement and the corresponding measurement in the real world. Map scale is usually expressed as a ratio, such as 1:24,000, which means that a measurement of one unit on the map represents 24,000 units in the real world.

Shapefile - is a digital vector storage format for storing geometric location and associated attribute information.

Spherical coordinate system: a coordinate system measured on the surface of a sphere, usually expressed as angular distances.
State Plane Coordinate System: a set of rectangular mapping coordinate systems defined in the United States. Each state is divided into one or more zones, and a separate coordinate system is defined for each zone.

Transfer file formats: digital-data file formats specifically designed to transfer data between different systems such as DXF™ and SDTS.

Transportation data: digital map data that describes transportation features, such as roads, railroads, or pipelines.

Universal Transverse Mercator (UTM): a specific implementation of the transverse mercator projection, designed for common usage around the world. The UTM system divides the world into 60 east-west zones, each of which is six degrees of longitude wide. Each zone is projected individually.

Vector: vector data is the storage of X, Y, Z coordinates connected to form points, lines, areas, and volumes. Vector data is best suited to store discrete, well-defined data that can clearly be delimited. Location of oil wells (points), street centerlines (lines), timber stands (areas), and groundwater tables (volumes) are good candidates for vector storage.

Shortcuts:

Navigating with your mouse:

Using the wheel mouse makes it easy to zoom and pan anytime you like without changing the tool you are currently using.

These shortcuts work in data view and layout view. In layout view, they apply to the page by default. You can hold down **Shift** and perform any shortcut to apply it to the data frame instead of the page (the active data frame in the case of rolling the mouse wheel, or the data frame you clicked in the case of clicking or dragging the mouse wheel).

Mouse wheel action	ArcMap navigation function
Roll wheel back and forth	Zoom in and out
Hold down **Ctrl** and roll	Zooms in and out but with finer increment. Use for small adjustments.
Click mouse wheel (or middle mouse button)	Center map at location where you clicked
Hold down mouse wheel (or middle mouse button) and drag	Pan
Hold down **Ctrl** and click mouse wheel	Center and zoom in at location you clicked
Hold down **Ctrl** and drag with the mouse wheel	Zoom in

Rolling the mouse wheel is applied to whichever part of the user interface the pointer is currently over. In this way, you can just move the pointer over the map and roll the wheel to zoom in or out, regardless of which window or dialog box has keyboard focus.

You can reverse the zoom in/zoom out convention used by the mouse wheel on the General tab of the ArcMap Tools > Options dialog box.

You can use the middle mouse button on a three-button mouse instead of the mouse wheel for all the shortcuts except for rolling to zoom in and out.

Temporarily changing any tool into a navigation tool

Hold down the following keys to temporarily turn the tool you are currently using into a navigation tool:

- **Z** = Zoom In
- **X** = Zoom Out
- **C** = Pan
- **B** = Continuous Zoom/Pan (Drag with left mouse button zooms in/out, drag with right mouse button pans.)

These shortcuts work in data view and layout view. In layout view, they apply to the page by default. Hold down **Shift** as well as the key to apply it to the data frame you click on instead of the page.

Re-centering the map with one click

You can quickly re-center the map when you use the pan tools.

- Click with the Pan tool  re-centers the data frame at the location you clicked.
- Click with the Layout Pan tool  re-centers the page at the location you clicked.

Continuous Zoom/Pan tool

The Continuous Zoom/Pan tool  can be added into any toolbar in the ArcMap user interface from the Pan/Zoom category of the Tools > Customize dialog box. This tool is especially useful if you want to have a dynamic zooming and panning capability but don't have a mouse with a wheel.

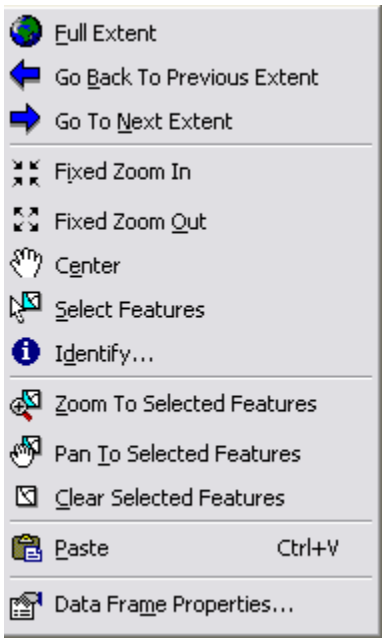
- You can temporarily turn any tool into this tool by holding down the **B** key on your keyboard. The Continuous Zoom/Pan tool does not have to be added into your ArcMap user interface for this to be available.
- You can reverse the zoom in/zoom out convention on the General tab of the ArcMap Tools > Options dialog box.
- When this tool is active, you can re-center the map by clicking with the right mouse button, in addition to panning the map by dragging with the right mouse button.
- The Continuous Zoom/Pan tool works on the page when you are in layout view. Hold down **Shift** to operate on a data frame when you are in layout view.

Other navigation shortcuts

- When the Zoom In tool, Zoom Out tool, or Pan tool is active, **F6** toggles among these three tools. **F6** also toggles among the corresponding three layout tools when you are in layout view.
- The **arrow keys** scroll the map in the direction you press, unless a graphic or map element is selected, in which case they nudge that element.
- The **Home** and **End** keys also scroll the map left and right. **PageUp** and **PageDown** scroll the map up and down.
- The + and - keys zoom in and out, the same as the Fixed Zoom In and Fixed Zoom Out buttons.
- The < and > keys zoom go back to the previous extent or forward to the next extent, the same as the Back and Forward buttons.
- The **Insert** key takes you to the full extent, like the Full Extent button.
- Hold down **Alt** and click the name of a layer in the table of contents to zoom to the extent of that layer.

Navigating with context menus

Right-clicking the map in data view gives you a menu containing a set of commonly used commands. The menu includes some commands that operate at the location you right-clicked, enabling you to perform an operation once without changing your current tool.



This menu doesn't appear if you right-click the map in data view when you are using certain tools, such as some of the editing tools, that have their own specialized context menus. However, you can customize the existing context menus of those commands to include any of the navigation commands.

You can also access the navigation context menu when you are working with a viewer window. A viewer window lets you pan and zoom the contents of the window independent from the main ArcMap window. All the commands are available except for Go Back To Previous Extent and Go To Next Extent.

You can also customize this menu to add additional commands into it as shortcuts, but remember that some commands only work in particular menus. For example, the commands in the context menu you get when you right-click a layer in the table of contents won't become enabled if you add them into other menus.

References:

ESRI is responsible for providing the majority of the information listed in this training guide.