

MAPPING EXERCISE

Creating a Base Map

GIS map layers come in many forms and are available from a wide range of sources including public agencies and private firms. Even though a large amount of spatial data currently exists, it is common in mapping for a cartographer to create “from scratch” base maps to be used in mapping and GIS analysis. Digitizing data involves tracing over pre-existing maps or photographs using a digitizing tablet (for hard-copy maps and photos) or onscreen (for digital maps and photos). In this exercise you will use the onscreen or “heads-up” method in ArcMap in which you will trace over an aerial photograph.

When creating map layers for GIS, it is important that they are able to align with existing geographically referenced, or georeferenced, data. In this exercise, the photograph you are using is already georeferenced. If it were not, you would need to align it in its proper geographical context—a process called georeferencing. You will not do georeferencing in this exercise.

In this exercise, you will:

- ✓ Use ArcCatalog to create map layers
- ✓ Create a spatial bookmark
- ✓ Use the Edit toolbar
- ✓ Draw map features
- ✓ Modify symbol properties
- ✓ Create a map layout
- ✓ Create a Legend using the Legend Wizard
- ✓ Insert a scale bar and north arrow

Opening the Project

- Start ArcMap (**Start All Programs >ArcGIS >ArcMap**); if there is an icon on the computer desktop, you can start ArcMap by double-clicking it. You will be shown a window asking whether you want to open a new empty map, a template, or an existing map.
- Make sure the **An existing map:** radio button is selected and click OK. If you did not see this window, click **File >Open**.
- Browse to where you saved the **basemap.mxd** project file and open it. You will see an air photo of a neighborhood in southeast Macomb, Illinois.

You will create new map layers and draw them based upon the air photo. As you progress through the lab, you will zoom in and out frequently. A spatial *bookmark* called “Mapping Area” exists so you can return to the same view as when you opened the project file.

i A bookmark identifies a particular spatial extent of the map that you can save and return to. You may return to your bookmarked location by clicking **View >Bookmarks**. A GIS project in ArcMap can have multiple bookmarks. To create a bookmark, fill the Data View with the desired geographical extent and go to **View >Bookmarks >Create**.

- Take a few moments to move around the photograph. Zoom in, zoom out, pan around. When you are done, click **View >Bookmarks >Mapping Area** to return to the extent of the photograph.

When you create items during this part of the exercise, you will want to be zoomed in much more than the extent of the spatial bookmark. You can zoom in even further to get maximum detail and then zoom back out.

When creating base maps for use in GIS software, create a separate file (layer) for each of the feature types that you will place on the map. For example, make city blocks one layer and structures another. Similarly, rivers would be one layer while lakes another. On the other hand, different types of the *same* feature are put in a single layer. By having multiple layers, you can easily turn features on and off and reorder them in the Table of Contents. In the photograph, you may have noticed there are a handful of feature types that you can digitize: city streets, city blocks, structures (houses, garages, etc.), a creek, and vegetation (trees, bushes, etc.).

In city infrastructure mapping, there are two common ways that city streets are represented. The first, and most common, is to draw city streets as lines. In this method, the line is drawn down the center of the street. Information such as the street name, address ranges, street width, and surface type can be included in the attribute table. The second method, common in land use mapping, is to draw the blocks as polygons. In a city where there are hundreds or thousands of blocks, the empty space between the blocks represents the streets. While many maps use one or both of these methods, you will do the latter for this exercise.

In order to draw the features, you must first create **new shapefiles** for your map. To do this, you will utilize the **ArcCatalog** program. As you will recall from the *Getting Started* exercise, shapefiles contain vector data and they are not single files but rather collections of related files.

i ArcCatalog does what its name implies: it allows you to build a catalog of your geographic data. Through your catalog, you can manage and access your geographic data stored in folders that you *connect* to. Within your connected folders, you can browse your data as well as examine its associated attribute tables and metadata. You can also create new data and insert it into an ArcMap project by dragging the file to the ArcMap Table of Contents.

- **Launch ArcCatalog** by clicking the **ArcCatalog button**.



Figure 1. ArcCatalog button.

- In the left-hand window, navigate to the location where you stored the files for this exercise. If this location is not visible, click the **Connect to Folder button** and locate this folder.

You will now create an empty shapefile.

- Making sure that your folder is highlighted in the ArcCatalog Table of Contents, select **File >New >Shapefile**. Note that while you do not *have* to create the shapefile in this folder, it is a good idea to keep all project files together in one location. A dialog box appears where you can set several characteristics of your new shapefile.
- First, name the shapefile **Blocks** and make the Feature Type **Polygon**. **Do not** click OK yet.

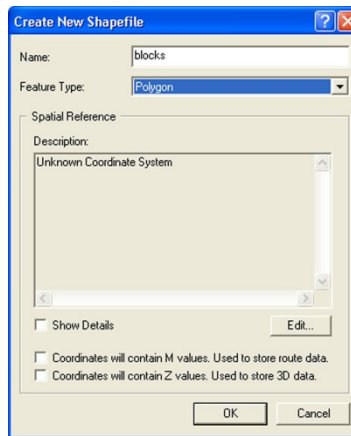


Figure 2. Use this interface to define the shapefile properties.

The photo in the project has a spatial reference assigned to it. Because you are going to be adding data layers on top of the photo, it is best to set the spatial reference for your new shapefile to match the photo.

- The photo uses the NAD 1983 State Plane Illinois West coordinate system. To set the coordinate system of your new shapefile to match this, press the **Edit button** under the window which currently reads “Unknown Coordinate System.”
- A **Spatial Reference Properties** window opens. Press the **Select button**.
- A **Browse for Coordinate System** window opens. **Double-click Projected Coordinate Systems**
- **Double-click State Plane**
- **Double-click Nad 1983** (not NAD 1983 (feet) or Nad 1983 harn)
- **Select NAD 1983 StatePlane Illinois West FIPS 1202.prj** and press the **Add button**.

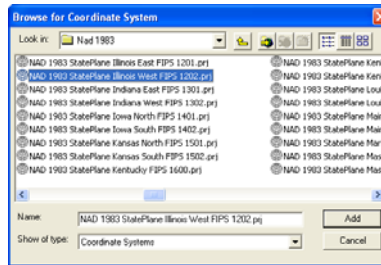


Figure 3. Make sure you select Illinois West, not Illinois East.



You were guided through the previous steps in order that you may be exposed to the number of available coordinate systems as well as to their organization. There is an alternate (and easier) method of assigning the coordinate system when you wish to match a shapefile's coordinate system to an existing layer.

Rather than using the Select... button in the Spatial Reference Properties window, click the Import... button. Next, navigate to the file with the known coordinate system and select it. The coordinate system attributes will be imported to your new shapefile.

If you do not assign a coordinate system to a shapefile when it is created, you may always do so later. In ArcCatalog, navigate to the shapefile in question, right-click the file name in the Table of Contents, and select Properties. Select the XY Coordinate System tab in the properties window and repeat the steps above.

- **Press OK** to return to the “Create New Shapefile” window.
- **Press OK.** You now have a new, projected shapefile called “Blocks.”
- Now create:
 - Another **polygon** shapefile called **Structures**
 - A **polyline** shapefile called **Streams**.
 - A **point** shapefile called **Trees**.
 - Remember to set the coordinate system for these shapefiles to NAD 1983 StatePlane Illinois West FIPS 1202.
- **Close ArcCatalog.** Back in ArcMap, **add the three shapefiles you just created** using the **Add Data** button (**Figure 4**).



Figure 4. The Add Data button.

- Arrange the layers in the Table of Contents so the **Blocks** layer is below the other layers by dragging the layer name downwards.

- You will begin by adding polygons to the Blocks shapefile. If the Editor toolbar is not visible, turn it on (**Tools >Editor Toolbar** or press the **Editor Toolbar** button on the standard toolbar).



Figure 5. The Editor Toolbar button.

- To start adding features, click **Editor** and then select **Start Editing**.

Note the two drop-down menus in Figure 6. The first shown is the **Task menu**. This menu is where you specify the editing task you wish to utilize. The next is the **Target menu**. The target is the shapefile where the edits will be recorded. By default, ArcMap sets the target to the layer that is at the top of the Table of Contents.

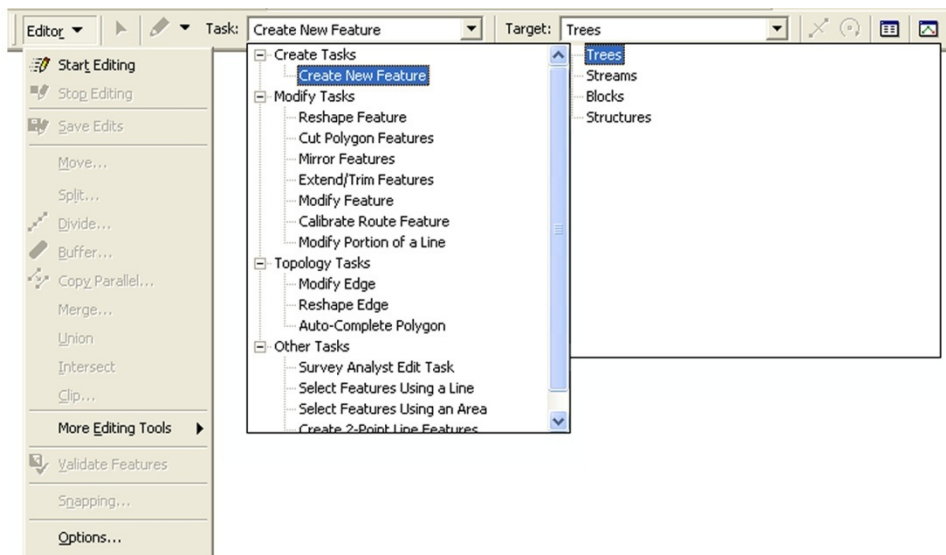


Figure 6. The Editor Toolbar

- You will be adding features to the **Blocks** shapefile first, so make sure the Task is set to **Create New Feature** and the Target is set to **Blocks**.

Use the **Sketch Tool** (the pencil button) to create the polygons for the blocks shapefile. Note the drop-down arrow to the right of the Sketch tool. There are several sketching tools that you can use in ArcMap.

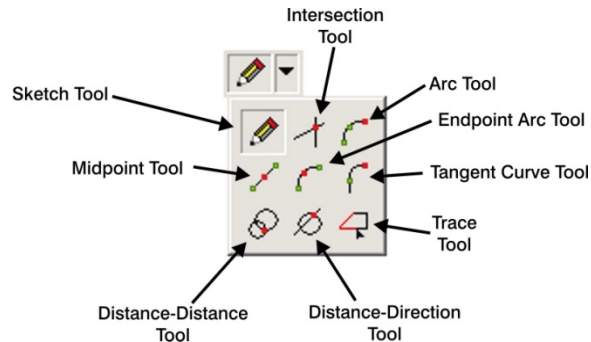


Figure 7. The various sketching tools in ArcMap.

- Now start drawing your block polygons.
- Zoom in so you can see the edge of a block in greater detail. Be careful not to zoom in so far that it becomes difficult to make out the block edges.
- Now, start clicking around the **edge** of the block (do **not** go down the middle of the street) and **double-click** to finish the polygon.
- When you are drawing polygons or lines, **click once** to start the feature. Move your mouse around the edge of the block, clicking **once** to add additional vertices.



The more you are zoomed in, the more accurate your polygon will be so zoom in to a point that you can see only *part* of the block. A handy feature in the editing mode is that if you need to see beyond the visible area of the photo (i.e., you need to scroll up or down, left or right) you can click the scrolling arrows and still be able to add vertices to the polygon you are creating. Be careful not to scroll too far in any direction as you want to be able to see the last vertex you drew.

If you are using a mouse with a scroll wheel, you do not need to use the scroll arrows to **pan** the image. Simply depress the scroll wheel and move the mouse to pan the image. You can also use the scroll wheel to **zoom in** (roll the wheel down—towards you) or **zoom out** (roll the wheel up—away from you).

- **Double-clicking** (or pressing the **F2** key) will finish the feature you are drawing and close the polygon. You do **not** have to be back on the original vertex—ArcMap will automatically connect the last vertex you drew to the first one. Be aware that this last segment is a **straight line**. If you are too far away from the original vertex you may end up with an awkward looking segment of your polygon.
- Click around the edge of the block to add vertices. For portions of blocks that extend beyond the photograph, use the edge of the photo as the de facto edge of the block. When you get back to your starting vertex, double-click or press the F2 key to finish the polygon.

A completed polygon will display the symbol properties (fill color and outline color) shown in

the Table of Contents. The most recently completed feature will also be *selected*—noted by the cyan outline. Clearing the selection (**Selection >Clear Selected Features**) will remove the cyan highlighting.

For sides of blocks that are curved rather than straight lines, which is most of the blocks, make sure that your line follows the curve. You will want to have enough vertices so that the block edge does not have obvious and sharp changes in direction. You also need to make sure that you do not have *too many* vertices as this situation can produce block edges that seem to have several small undulations. It may take some practice to produce the sweeping curves of some of the blocks. You may wish to use the various arc or curve drawing tools (**Figure 7**) for curved features.

When you are sketching, you can zoom in and out, pan, and switch between sketching tools without finishing the feature. This capability is very useful for blocks with straight segments but rounded corners. In cities it is rare for a city block have a corner that is a sharp 90° angle.

- To make editing a bit less cluttered, **click once** on the Blocks **legend** (the colored box below the layer name) in the Table of Contents. Doing so will open the **Symbol Selector** window.
- Select the **hollow** box (note the preview window in the upper right-hand corner of the window—this will show you what the polygon will look like as you change attributes). **Also**, change the **Outline Width** thickness to 1.5 (click in the window and type 1.5) **and** using the drop-down arrow, **change the Outline Color** to a **red** (it will show up better against the dark grays of the air photo than the default grey border color). Press OK.

Your final map will be displayed without the map. It is a good idea to occasionally turn off the photo in the Table of Contents to see what your map looks like. You may discover that some map features look good with the photo as a background but not as good without it.

If you wish to make changes to a polygon, use the **Edit** tool.



Figure 8. The Edit tool. Use this tool to modify or move selected features.

- As you progress through this process, occasionally press the **Editor button** and select **Save Edits**. Your shapefile will be updated.
- When you are done drawing all the blocks save your edits one more time.

i Double-click a completed polygon with the Edit tool to display its vertices. The Edit tool allows you to perform the following tasks:

- ✓ Move an existing vertex by dragging it to a new location (the mouse pointer will change when you are over a vertex).
- ✓ Delete an unwanted vertex. Move the mouse over the vertex (again, the pointer will change), right-click and select **Delete Vertex** from the context menu.
- ✓ Insert a vertex. Move the mouse to the location along the line where you want to add the vertex, right-click and select **Insert Vertex** from the context menu.
- ✓ Move the entire polygon. You may reposition a *selected* polygon by clicking and dragging it. You do not need to double-click the polygon with the Edit tool first. Note that you must use the Edit tool to do this. Using any of the other pointers will not work.

Next you will draw polygons that conform to the houses in the green boxed area.

- Staying in edit mode, **switch the target** to the **Structures shapefile**.
- Follow the procedure you used to draw the blocks, try as best as possible to draw your polygon around each house.

When drawing structures, you want the shape you are drawing to conform to the “footprint” of the house. With aerial photographs, it is very difficult, if not impossible, to see a building footprint. You can see the roof, however.

- Use the roofline to serve as a surrogate for drawing the footprints of structures (the presence of eaves on houses means that roofs are usually slightly larger than the building footprint—don’t worry about this discrepancy at this time). **Digitize around the edge of the roof.**

Because the photo is taken at an angle slightly off from vertical, most of the rooftops are not directly over the footprint (base) of the structure. After you have finished a polygon, move it so it conforms to the location at the *base* of the building. The easiest way to do this is to locate a corner at the base of the house and then move your polygon so the corresponding corner is in this location. You may be forced to use your best judgment about where some of “footprints” are exactly. Because this is only an exercise to teach you the techniques, don’t worry if you don’t have it exactly right.

Be careful to have 90° angles for your roofs! It is easy, especially when zoomed in, to follow the pitch of the roof when digitizing. Digitize from *corner to corner* of the roof—be careful not to accidentally digitize from corner, to roof peak, and then back to the other corner. It’s a good idea to view your house polygons without the photo to see if you have drawn them with straight edges.

i On complex polygons, you can digitize 90° angles without having to “eyeball” the angle. You can use the **Deflection Angle** tool. To use this tool, you must first digitize one side of your polygon. Note: You can enter any angle in this manner; it does need to be 90°.

- Next type **Ctrl+f** (the Control Key and the F key simultaneously) to open the

Deflection Angle dialog.

- Type 90 and hit enter.
- As you move your mouse, it will be “locked” in a right angle from the previous line. Simply move your mouse to the end of the new line and click.
- Repeat as necessary.

- When you are done drawing the structures, you will draw the creek that flows through the middle of the photo. Switch to the **Target** to Streams before drawing the creek
- Remember, the Streams layer is a **polyline**, not a polygon layer. Draw a **single line** down the middle of the creek (do not go down one edge and come back on the other). The creek does traverse the width of the photo. In places where it is obscured by trees (like at the west edge of the photo), use your best judgment about the stream location.
- Double-click (or press F2) at the **end** of the stream length to complete the line.
- Remember to occasionally **save your edits**.

Finally, you will digitize locations for trees.

- Switch the Target to **Trees**. As this is a point layer, you will need to click just one time to create a feature.
- Digitize the base of each tree (as best as you can see). Do not digitize shrubs, bushes or hedgerows.
- Remember to occasionally **save your edits** as you go along. When you are done editing, select **Stop Editing** from the Editor menu. If you are asked if you wish to save your edits, select **Yes**.



You probably noticed that there were several instances where it was very difficult to determine a block edge, roof edge, base of tree, etc. because of limitations in the photograph. In most cases, these limitations can be overcome by having increased familiarity with the specific features being digitized—oftentimes accomplished by field-checking.

- You will print the layout **WITHOUT** the air photo. **Turn it off in the table of contents**.
- After you have turned off the photo, evaluate how all your map features look. Because you will be printing the map without the photo, you need to make sure that the map looks good without it.
 - ✓ Make sure no elements go beyond borders (e.g., don’t have buildings extending into the street or past the edge of the photo).
 - ✓ Make sure the streets look reasonable—don’t have varying widths of the streets within a block and try to keep them uniform along the street length.

- ✓ If you need to adjust any feature, go back into edit mode and make the adjustments. Don't forget to save your edits!
- Color your layers using the Symbol Selector (click on the layer's legend in Table of Contents)
 - ✓ *Blocks layer*: Make the fill color **beige** and the outline 1.0 thick and **black**
 - ✓ *Buildings layer*: the buildings **Suglight Sky** (the light blue at the top of the third column from the right in the color palette—put your mouse over the color to reveal its name) with a **Gray 70% border**.
 - ✓ *Streams layer*: Choose the **River** symbol and make the width **3.0**.
 - ✓ *Trees layer*: Choose the **Circle 2** symbol. Make it 4.00 points with a **Spruce Green** fill color.

Creating a Map Layout to Print

Now we'll create a draft map layout.

- First, **turn off the photograph** by deselecting its check box in the Table of Contents.
- Zoom to the Mapping Area spatial (View >Bookmarks >Mapping Area).
- Switch to the **Layout View** (use the Layout View button or View >Layout View).

You will now see your map and layers displayed in a page with the map positioned to the right of center (**Figure 9**).

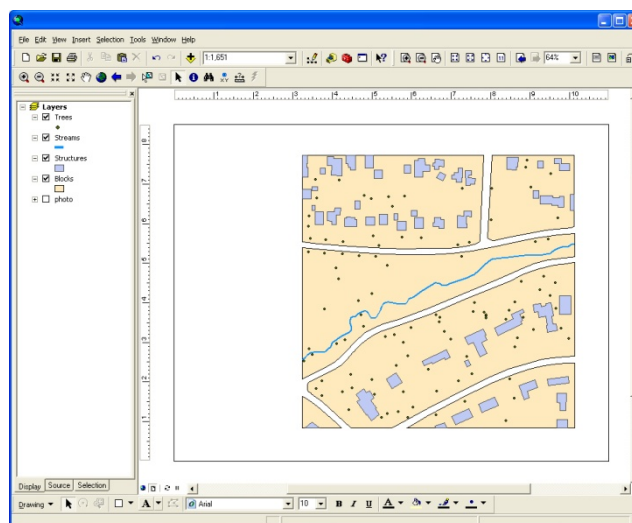


Figure 9. The map in the Layout View.

- Right click outside of the data frame (the highlighted box on the page) and select **Page and Print Setup** from the menu.

- In the “Paper” area, change the layout to **Landscape**; in the “Map Page Size” area, make sure the **Use Printer Paper Settings** box is checked. Make sure the **Show Printer Margins on Layout** box is checked. Click **OK**.

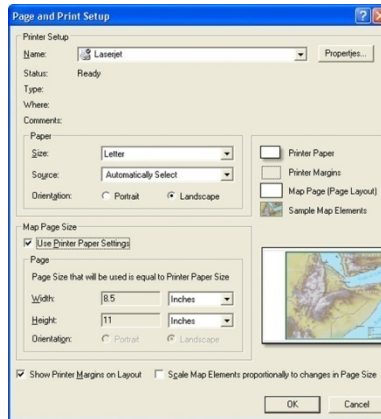


Figure 10. Page and Print Setup.

Prior to printing, you will add a few more elements.

First, you will draw a neatline around the mapped area.

- Using the **New Rectangle** button on the **Draw toolbar** (usually located at the bottom of the display environment), draw a rectangle that is flush with the map edges (start in one corner and click-and-drag to the opposite corner).
- Double-click on the box to open the Properties window. Make the Fill Color **no color**, the Outline Color **black** and set the Outline Width to **3**. Click **OK**.

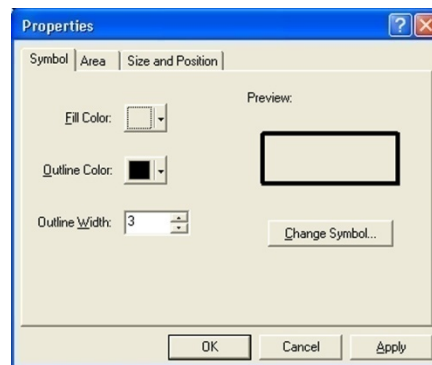


Figure 11. The Properties window for the rectangle you just drew.

- Insert a **neatline around the entire map layout** (Insert >Neatline) with the following settings: Place **inside margins**, make the Gap **10 points**, make the Rounding **0%**, make the Border **2 points** thick, and make sure **no colors** are specified for the Background and the Drop Shadow.
- Add the following map title (**Insert >Title**): **Digitizing in ArcMap** on the map. Change

the font to **Times New Roman**, the size to **28** and the style to **bold**. Click **OK**.

- Place the title in the space to the **left of the mapped area** inside the margin. Move the title so the top of the lettering is roughly flush with the top of the mapped area.

You may have noticed that the title is wider than the space available. To make the title fit, you will need to place the text on two lines.

- Double-click the title to open the **Text Properties** window. Move your mouse after the word Digitizing and press the Enter key. When you typed the title, you inserted a space between “Digitizing” and “in.” Make sure this space has been deleted.
- Keep the text alignment to Center (the default) and press OK to register the changes.
- Using **Insert >Text**, put the cartographer’s information in the **bottom left-hand corner** of the map **inside** and **close** to the neatline (**left-justified, 10 point, Times New Roman**):

Your name
Today’s date

- Add a scale bar (**Insert >Scale Bar**). Select the first scale bar (**Scale Line 1**).

When placing a scale bar on a map, you want it to be meaningful to the reader. Note the interval on the current scale bar. When ArcMap inserts a scale bar, it creates a scale bar of a set width and divides this width into equal map units. Unfortunately, doing so can create an awkward scale bar—e.g., intervals of 724 feet (who conceptualizes distance in 724-foot units?). You will need to adjust your scale bar to something more meaningful.

- Click the properties button (double-click the scale bar if you clicked OK and returned to the layout). Scale bars should have logical, rounded numbers and units. Make the division units **feet**, the label position **below bar**, the number of divisions **5**, the number of subdivisions **0**, when resizing to **adjust width** and the division value to **50 ft**.
- Reposition the scale bar so it is above the cartographer’s information, centered in the available space.
- Next, add a **north arrow** (Insert >North Arrow). Place the north arrow above the scale bar.
- Finally, you will **add a legend**. When you insert the legend (Insert >Legend), the Legend Wizard opens indicating the available map layers and which are included in the legend. By default, all map layers are included in the legend.
- Because Blocks is essentially background information, you do not need to include it in the legend. Remove it from the list by highlighting in the Legend Items list and clicking the left arrow.

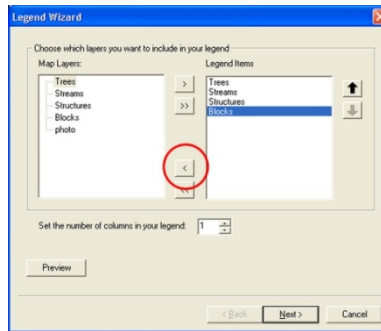


Figure 12. The Legend Wizard allows you to add or remove layers from the legend.

- Click **Next**. **Do not** change any of the title properties. Click **Next**.
- **Do not** add a Border, Background color, or Drop Shadow. Click **Next**.

In the following window, you can change the size, shape, and symbol used to represent line or polygon features. You will modify the Streams and Structures symbol (the Trees layer does not show up in this window as it is a point layer).

- With **Streams** highlighted, change the **Line** to **Flowing Water**.
- With **Structures** highlighted, change the **Area** to **Urbanized Area**.

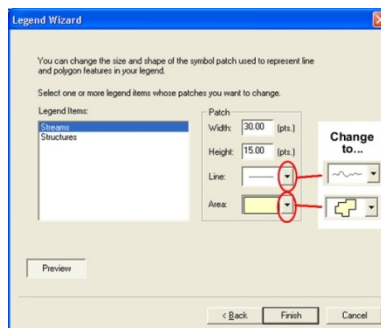


Figure 13. Use the arrows next to the Patch Line or Area to change the symbol.

- Click **Finish**. Your legend should look like the following:

Legend

- Trees
-  Streams
-  Structures

Figure 14. You have a lot of flexibility

with legend design in ArcMap.

- Place the legend between the title and the north arrow.

If you have large empty areas in the space between the title and cartographer's information, you may need to move the scale bar, north arrow and/or legend so that these items are evenly distributed within the available space.

To print a hard-copy of the map:

- Click on the **print button** or select **File >Print** (you may also print preview using **File >Print Preview**)

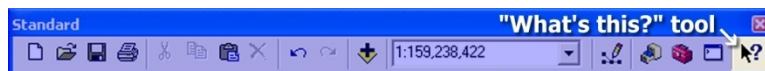
To create a PDF document (for digital submissions):

- Export the map by selecting **File >Export Map...**
- Change the **Save as type:** to **PDF (*.pdf)**. The Resolution should be **300** dpi and the **Output Image Quality** should be **best**.

Exercise Questions

1. What is a spatial bookmark?
2. What is ArcCatalog?
3. What steps do you take to create a new shapefile?
4. What is the difference between polygon, polyline, and point shapefiles?
5. What steps do you take to add features (e.g., houses) to a shapefile?
6. What tool (button) do you use to select and edit geographic features?
7. What is the Deflection Angle tool?

Identify what each of the following sketching tools does. Hint: switch to the tool in question, press the “What’s this?” tool, then click on the sketching tool.



8. Sketch tool
9. Arc tool and Endpoint Arc tool.
10. Tangent Curve tool and Midpoint tool.