

ArcGIS Basics: Somerville

Creating a Map with ArcMap



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Tufts Data Lab

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1. Introduction

This tutorial introduces you to ArcGIS 10.3.1 and shows you how to create a simple map using urban and state data sources. ArcCatalog and ArcMap are two modules in ArcGIS Desktop. You use ArcCatalog to manage your data and ArcMap to create maps, query data, perform analysis, and most of the other basic GIS operations. ArcMap is the module that you will use most frequently. The tutorial may take 3-4 hours to complete.

Download the tutorial data

Download the [GIS tutorial data.zip](#) file that accompanies this tutorial. The data can also be found in the S drive/Tutorials/Tufts/Tutorial Data/ArcGIS_Basics_Somerville. **Copy** and paste this zipped file to your H Drive.

If you're working in the Data Lab, **unzip this file to your H: drive into a new folder called ArcGIS Basics**. To do so, right click on the folder and click **Extract To → ArcGIS Basics**. At home or in another Tufts lab, unzip it in a location of your choice. This results in two subfolders containing data from MassGIS (the Massachusetts GIS Repository) and the City of Somerville, MA.

2. Previewing and Managing Data with ArcCatalog

ArcCatalog is one of the modules in ArcGIS. You use it to manage your data sets (copying, pasting, deleting, and reading metadata if available).

Starting ArcCatalog

Start ArcCatalog by going to **Start → All Programs → GIS Applications → ArcGIS 10 → ArcCatalog 10.3.1** (note: This might be in a different location in Boston or on the Grafton Campuses. Additionally, on your home computers with the ArcGIS student license installed, the ArcGIS program may be under *Programs → ArcGIS 10.3.1*).

The catalog tree on the left of the ArcCatalog window looks similar to a standard Windows file manager view, but the ArcCatalog tree only shows data that can be read by ArcGIS.

Understanding and Using Folder Connections

On the left side of the screen, you will see the **Catalog Tree**. This shows all of the locations where you can access GIS data. If you are in the Tufts Data Lab, you will see that you have three **folder connections** already – to H:, S:, and M:.

- The **H: drive** is your personal storage space.
- The **M: drive** holds data sets that Tufts has acquired for your use.
- The **S: drive** holds class specific materials.

The **folder connection** is a direct connection to these spaces in ArcGIS, and allows you to quickly access your data without navigating repeatedly through long folder paths.

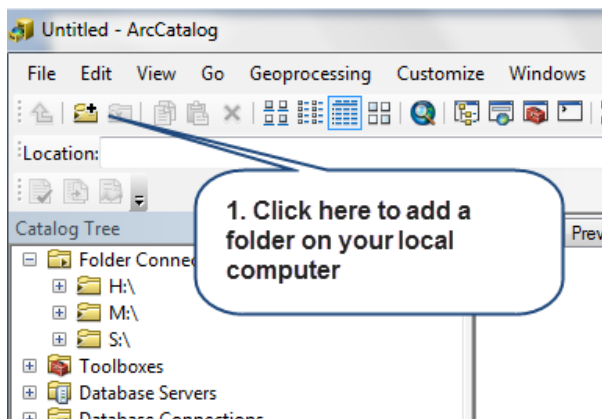
Working from Home or in another Tufts Computer Lab

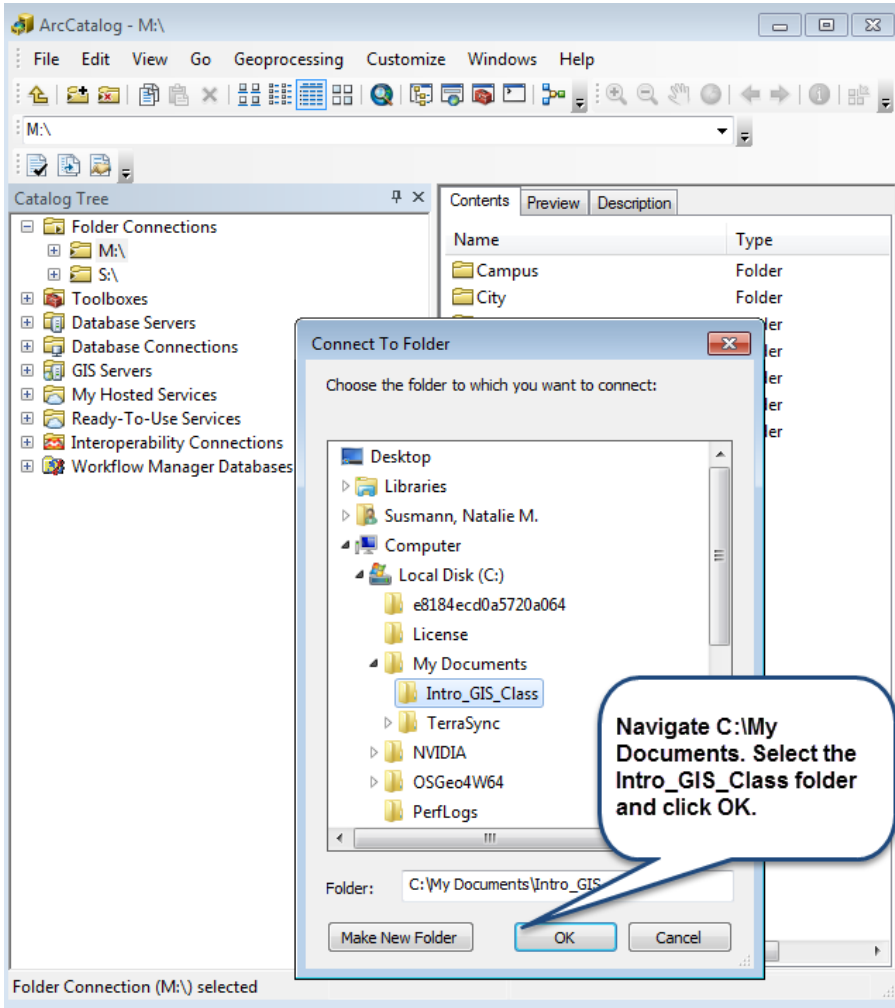
If you are working in the Data Lab, skip this section! Go to next section – Navigating in ArcCatalog (Middle of p. 4).

At home or other locations outside the Tufts Data Lab, you will not have pre-set folder connections. You will need to add these yourself. The first step is to think about how best to organize your work, and create the folders necessary in your home computer using your Windows software. We suggest making a folder for your GIS class, and then subfolders for your various assignments.

On your home computer, navigate to *My Documents* and make a folder called *Intro_GIS_Class*. Inside, make another folder called *ArcGIS Basics*. Open the *GIS_Tutorial_Data* folder you unzipped, copy the *Somerville* and *MassGIS* subfolders, and paste them into this *new ArcGIS Basics* folder.

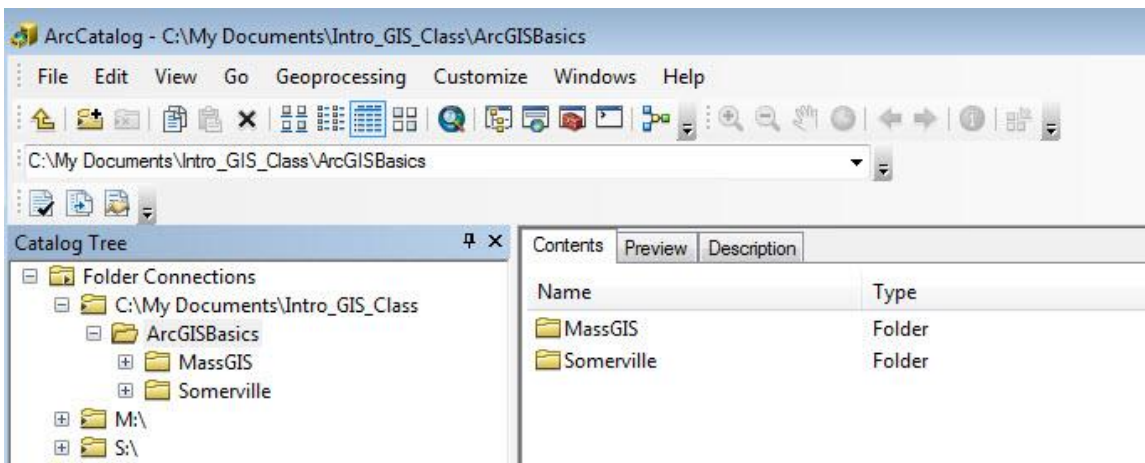
Now, you need to connect to this data in ArcCatalog. This is how I would create a **Folder Connection** to that folder in ArcCatalog:





Select only the folder! Don't drill down to the data itself! That way you have a connection to the folder *holding all of your data*.

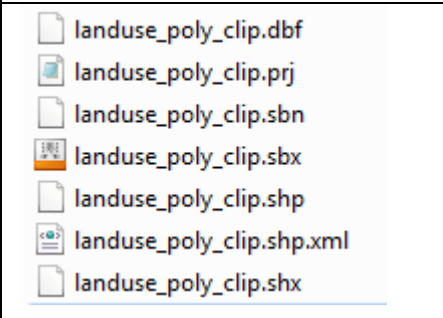
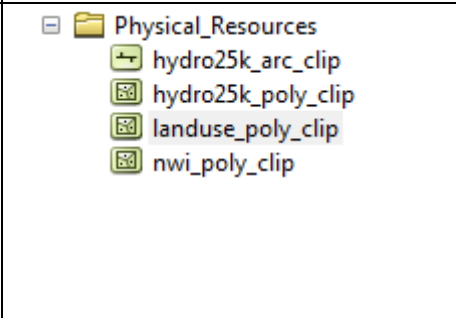
Look back to your **Folder Connections** in the **Catalog Tree** on the left side of the screen. Expand the **Folder Connections** folder if it is not already (by double clicking) and you will see your new connection, as shown below:



Navigating in ArcCatalog

1. In ArcCatalog, navigate to the location of the GIS data (in the Tisch Data Lab, this should be your *H:/ArcGIS Basics* folder)
2. On **the left side** of the window, click to open the *MassGIS/Physical_Resources* folder (click on the plus signs to expand the list and see the data within this folder)
3. Click on the *landuse_poly_clip* file. This is a data set from the state of Massachusetts showing land use polygons (e.g., residential, commercial, agriculture).

The *landuse_poly_clip* file is called *shape file*. This is a very common GIS data format, created by ESRI, the makers of ArcGIS. This is very important: **a shape file actually consists of several files**. Try looking at this file using Windows file manager within the regular windows folder. You will see several files making up that one Shape file as shown below:

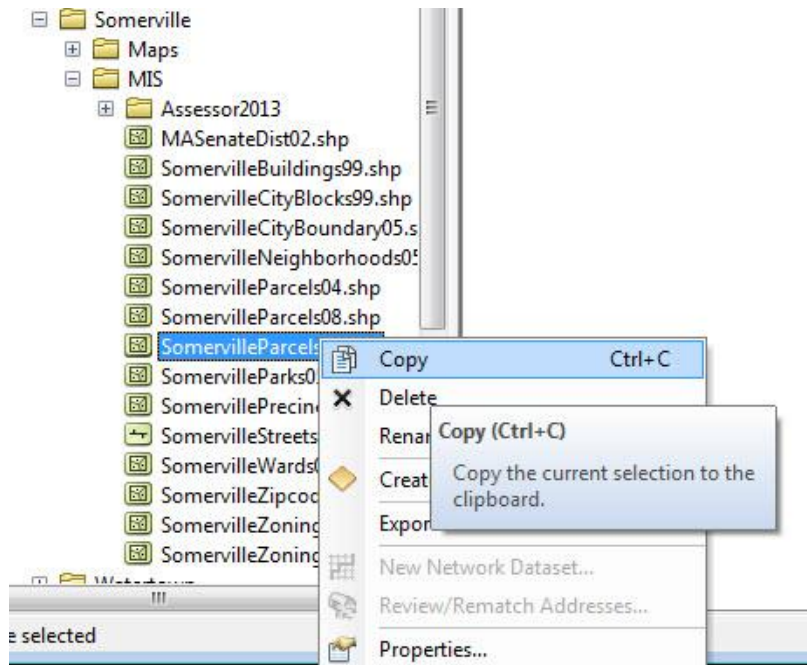
Windows File Manager View of <i>landuse_poly_clip shape file</i>	ArcCatalog Tree view of <i>landuse_poly_clip shape file</i>
	

All these files are necessary for this land use data set to be readable in a GIS software program. That's one reason why ArcCatalog is a better program than Windows File Manager for managing GIS data. If you copy *landuse_poly_clip* in ArcCatalog to another folder, the ArcCatalog program knows to copy all the associated data files with it.

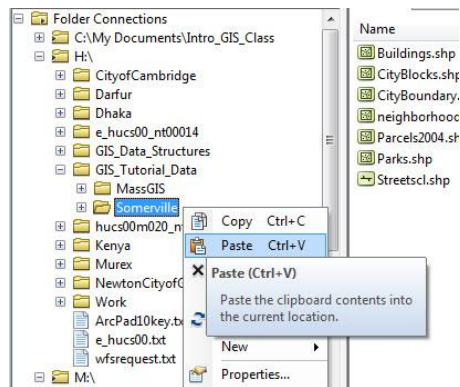
Copying and deleting GIS data sets in ArcCatalog

You can do the following ONLY if you are in the Tufts Data Lab! If you're working at home, skip this section and continue to the next section (*Previewing geography and attribute tables*)

1. In the Catalog Tree, look in the Somerville folder – you'll see a data set called **Parcels2004**. That's a bit dated for current mapping! We have a 2009 Parcels data set on our GIS data server that you can use for this tutorial if you have access to the Tufts GIS Data Server (M: drive).
2. In the *Catalog Tree*, navigate to *M:\City\Somerville\MIS*
3. Right-click on *SomervilleParcels09.shp* and choose **Copy**



4. In ArcCatalog, navigate back to your H: drive and the *Somerville* folder.
5. Right-click on the *Somerville* folder and choose **Paste**.



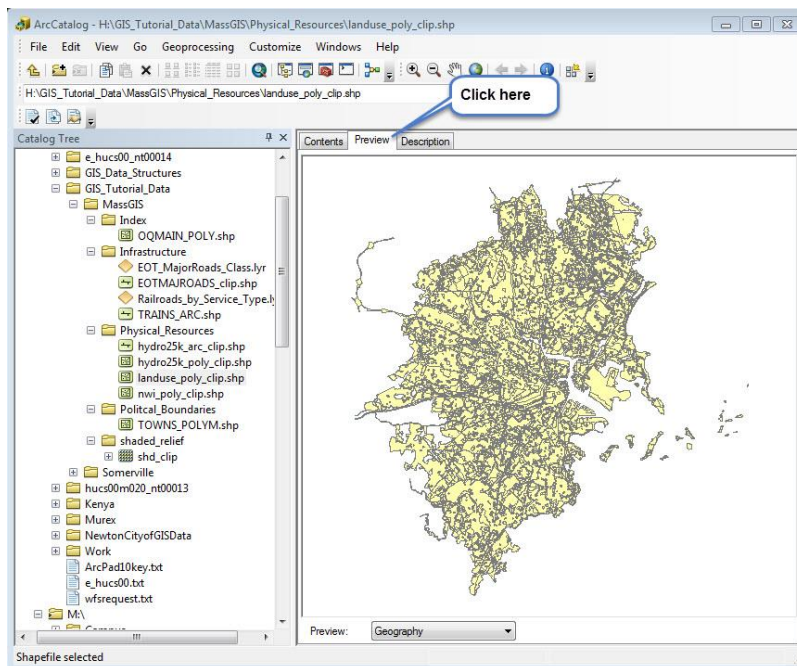
6. You should now see SomervilleParcels09.shp in the folder. If you successfully copied the 2009 parcels to your tutorial data set, then in the *Catalog Tree*, delete the *Parcels2004* data set on your H: drive – either highlight it and press the delete key or right-click on it and choose Delete (delete it **only** if you were able to copy the 2009 data set to your H: drive, otherwise do NOT delete *Parcels2004*! You can use the 2004 or 2009 data set for the rest of this tutorial).

ArcCatalog has helped you capture all of the associated files, and delete or copy them as necessary – you just had to click on one file. If you used Windows Explorer, you would have had to make sure you selected all of the associated files, shown below. That’s why it’s so important to use ArcCatalog for copying, deleting and renaming files:

2009 Parcel files making up the GIS data set	2004 Parcel files making up the GIS data set


Previewing geography and attribute tables

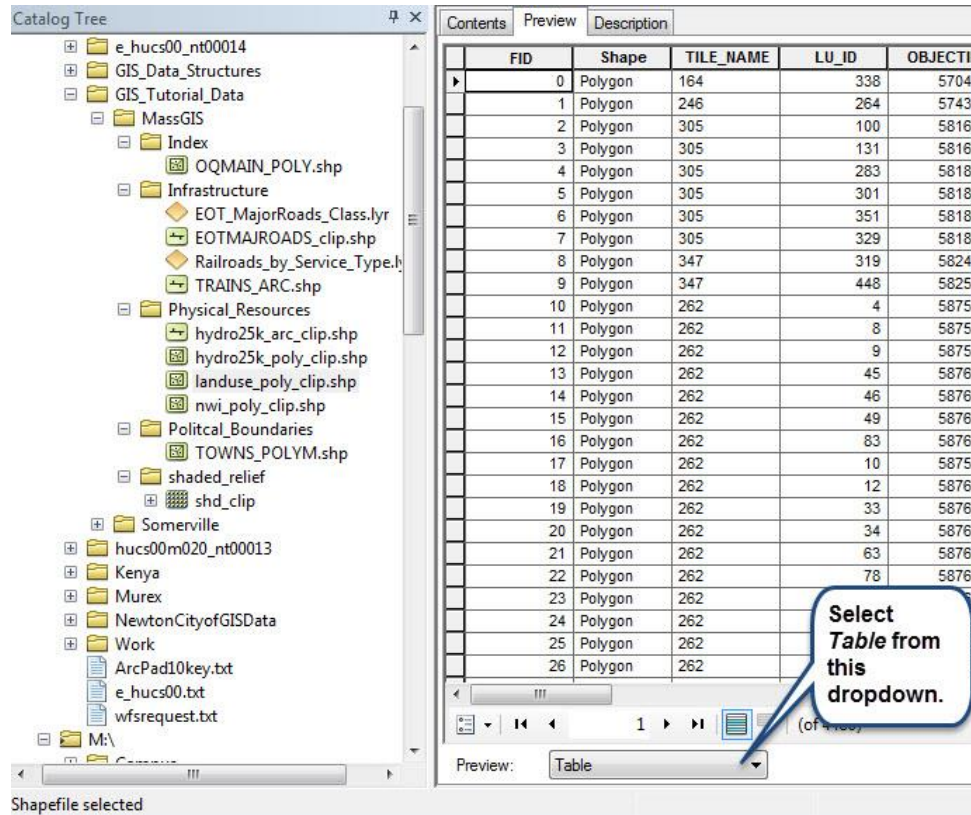
1. Click on *landuse_poly_clip* (located in MassGIS\Physical_Resources) in the catalog tree. Click on the *Preview* tab above the right screen pane in order to view the shapefile.



2. You should now see what *landuse_poly_clip* actually looks like.
3. Click on the *Identify* tool at the top tool bar () and then click on one of the **landuse** features in the shapefile. You will see the information stored in the attribute table about that polygon. It doesn't make much sense yet!
4. Use the zoom and pan tools () to zoom in and out and pan around in the preview map. With the zoom in tool (magnifying glass with a plus sign), you should use the mouse to draw a box around the area you want to zoom in to (click on one corner, keep the mouse button held down, and drag it to the opposite corner of the box before releasing). With the zoom-out tool, you also create a box - the current view will then be "zoomed

out" to fit inside the box you created. To use the pan tool, select the hand-shaped tool, then hold down the mouse button while you pan any direction to move the map. If your mouse has a scroll wheel, you can use that to zoom in and out.


5. To get back to the first (default) view, click on the world icon () - this takes you to the full extent of that particular data layer.
6. You can preview the attribute table (table of associated tabular information for a GIS data layer) by going down the *Preview* form and choosing *Table*. This shows all the records in the GIS layer. Scroll down and across to see the entire table.



Reading data documentation (metadata)

When you were previewing the land use data set, it was difficult to understand what it was supposed to be representing. And it was impossible to understand the coding scheme without further information. It is critical to have documentation about the data you are using, and to document data that you create. Data documentation is called *metadata*.

1. MassGIS, the statewide GIS clearinghouse, has excellent metadata online. Click here to read about the land use data set: <http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/lus.html>
2. Look through the land use data documentation. You can use this metadata to understand:
 - a) Is the land use data set up to date (i.e., do you know from this data set what an area's land use is **today**)?
 - b) For what years is land use documented?

- c) What was the source of information for determining land uses?
3. Scroll down the MassGIS land use metadata web page until you find information about the attributes and the codes that represent land uses.
4. Back in ArcCatalog Preview tab, preview Geography (so you see the map) and use the Identify icon  to click on it. What was that area's land use in 1971? Had it changed by 1999?
5. Metadata is also sometimes accessible within ArcCatalog, but only if the agency that created the data has written metadata in a format that ArcCatalog can read. With *landuse_clip_poly* still highlighted in the *Catalog Tree*, click on the **Description** tab above the map frame (located to the right of the **Preview** tab. Click **No** if you are asked whether to upgrade metadata. You will see a shortened version of the MassGIS metadata page here.
6. Try using ArcCatalog to read the description of other data sets in your MassGIS folder. Are all the data sets documented in ArcCatalog?
7. Do the same for some of the data sets in the Somerville folder. What do you find when you look at metadata for the Somerville data sets?

All US Federal agencies are required to document their GIS data following a geospatial metadata standard set out by the US government. Most state agencies will also document their GIS data, but not necessarily to the Federal standard. Local agencies vary widely in their documentation. Some do not document their data well or at all. Metadata is critical to data users - without it, you may not know what a particular data layer represents, when it was created, if it is complete, what the attributes mean, or what format it is in. We will discuss the importance of metadata more in class.

Get to know your data

Use what you have learned to look at other data sets in the GIS tutorial data set, including data for the City of Somerville. Preview the maps and tables, and look at the metadata. Note that you can see the full list of MassGIS data layers here: <http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/layerlist.html>. There is no equivalent online clearinghouse for the Somerville data.

Summary

ArcCatalog is a useful way to manage your GIS data, for organizational functions like moving, copying, and renaming. It also offers access to metadata if the source agency has put the documentation into a format that ArcGIS can read. In many instances, you'll find metadata online, or in a text file accompanying your data set. Sometimes, metadata may not exist at all. It's up to you to search for it and make sure you understand the data you are using.

You can also open ArcCatalog within ArcMap – this can be very helpful. We'll do this in the next part of the tutorial.

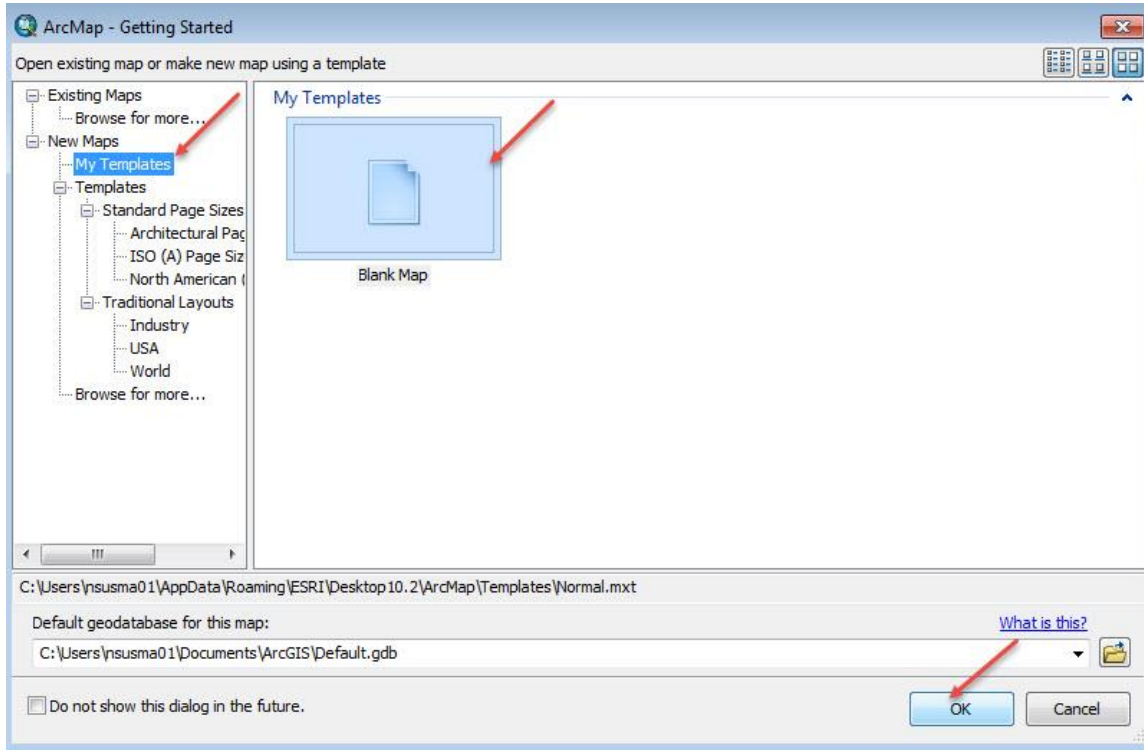
3. Creating a Map with ArcMap

You will now learn the basics of using GIS data to explore an area and create a map. Your efforts will be focused on Somerville, Massachusetts.

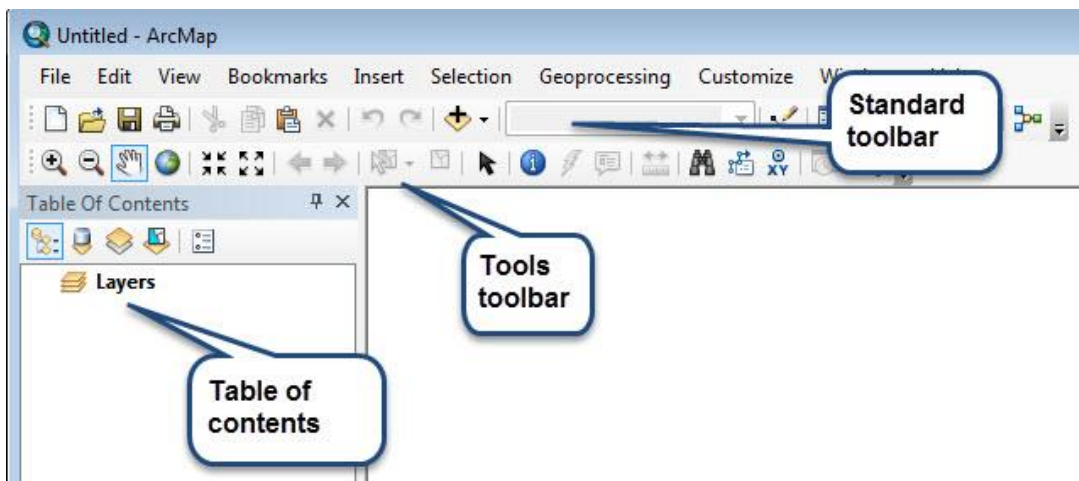
Opening ArcMap and adding data layers


To start ArcMap, choose **Start** → **All Programs** → **GIS Applications** → **ArcGIS 10.3.1** → **ArcMap** (*note: on home computers with the ArcGIS student license installed, the ArcGIS program may be under *Programs -- ArcGIS 10.3.1**). It will take a minute to start.

1. When the first dialog box comes up, highlight the option to start with a new blank map and press OK.

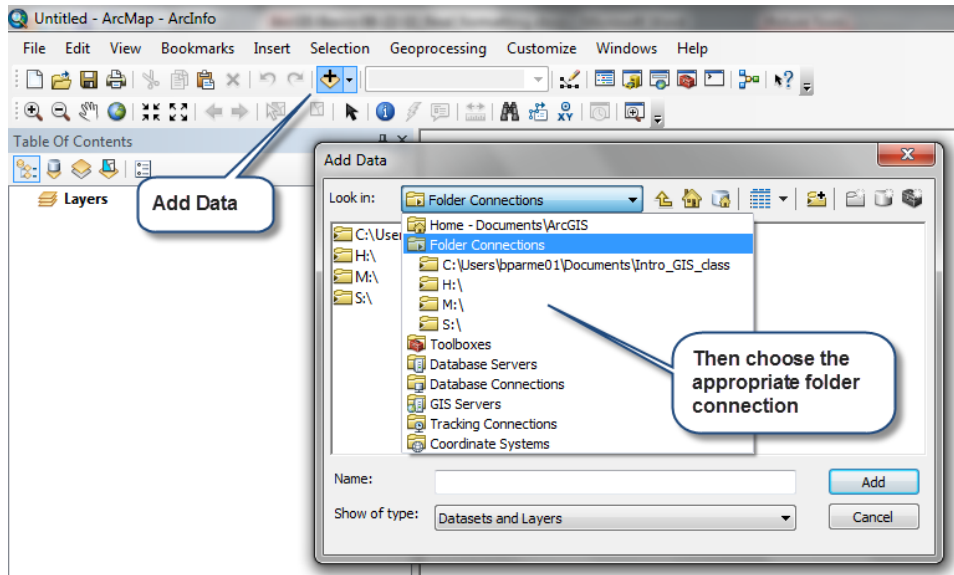


2. On the top of your screen, choose **Customize → Toolbars**, and make sure that *Standard* and *Tools* are visible. They will have check marks next to them; if not, click once on each.
3. On the left side of the screen, you should see your *Table of Contents* area. Right now it should only say "Layers". If you do not see this separate area, choose **Window → Table of Contents**.
4. Use the mouse to pass over the various tools that have been docked, and see what they do.

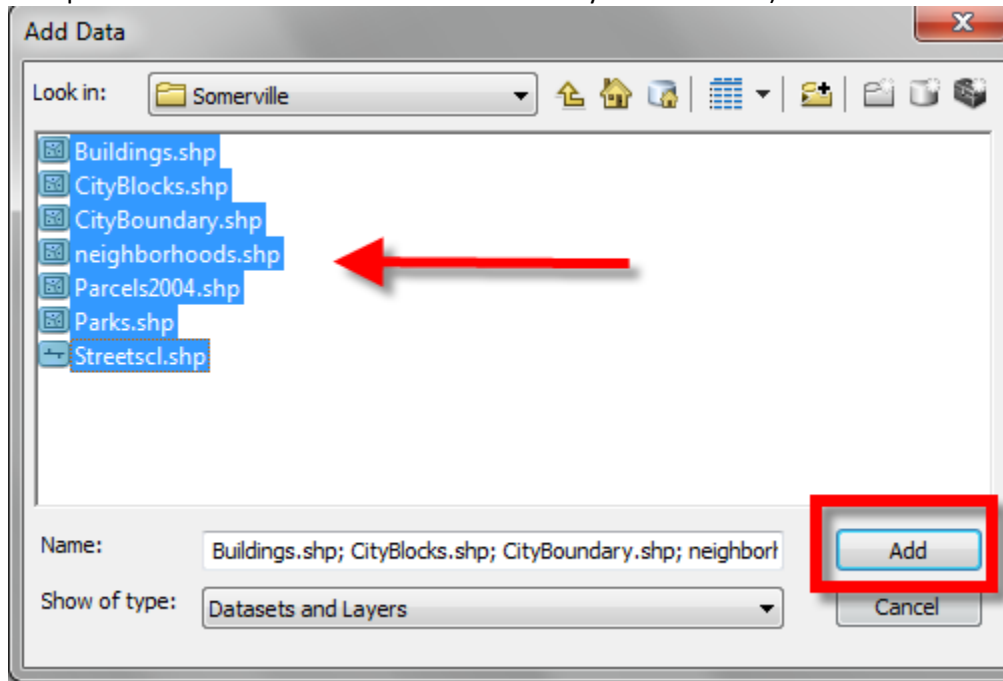


5. Click on the *Plus* sign  to **Add Data**
6. If you're in the Data Lab, you'll see a list of default *folder connections* (M:, S: and H:). Navigate to where you have stored the Tutorial Data Set (MassGIS and Somerville). In the Data Lab that will be your H: drive. If you're

working outside the Data Lab, and you have already made a folder connection in ArcCatalog, it should be available under *Folder Connections* in ArcMap:



7. Navigate to the Somerville folder and add all the data layers you see below (hold down the CTRL key to select multiple files at once – substitute 2009 Parcels if you have those):

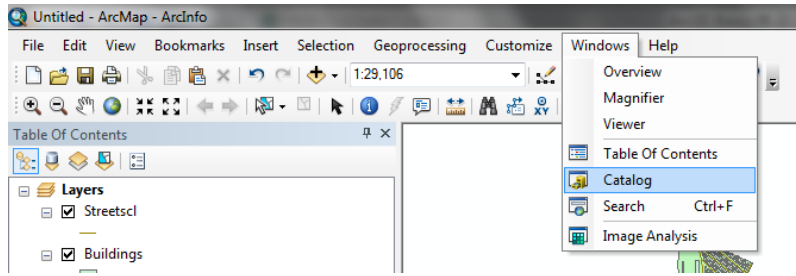


If you missed adding one of the layers, click on the **Add Data** icon again and add them.

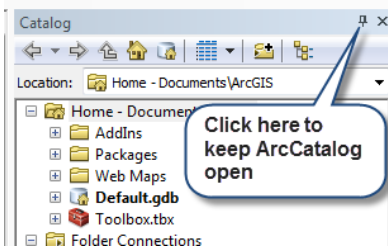
Using ArcCatalog within ArcMap to Add Data

It's often useful for data management to have ArcCatalog open *within* ArcMap, and this also provides another way of adding data.

8. Within ArcMap, choose **Windows → Catalog** from the main menu – this adds ArcCatalog to your ArcMap session.



9. Click on the *auto-hide* pin icon in the top right corner of the *Catalog* box to pin it in place (otherwise it disappears after every interaction).







Note: In the Tufts Data Lab you should have at least three *folder connections* in addition to any folder connections you have added manually.

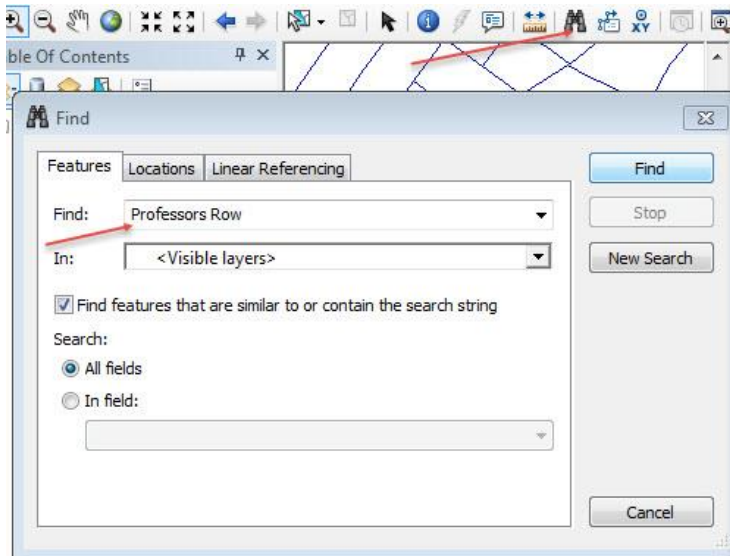
10. Expand the folder that has your GIS tutorial data set and navigate to **MassGIS → Physical Resources**.
11. **Click and hold** on the *Hydro25k_poly_clip* file and **drag** it into your ArcMap window – after it draws, take a look at it – what does it seem to represent?
12. Drag *Hydro25k_arc_clip* into your ArcMap window – what does it represent? (hint: MassGIS has metadata here: <http://www.mass.gov/mgis/hd.htm>) Your map is a bit of a mess with all these layers!
13. In the *Table of Contents*, turn off (uncheck) all of the data layers except for **street centerlines (Streetscl)**, **hydro25k_poly_clip**, and **parks**. They should remain listed in the *Table of Contents*, but should not be visible in the map view.

Now you know two ways to add data to a map: by using the *Add Data* button, or by dragging them from *ArcCatalog*. It is very handy to have ArcCatalog open in ArcMap while you work, so you should get used to making its window visible at the beginning of every ArcMap session (remember to pin it in place!)

Getting around a map

1. Zoom in to a part of Somerville using the *Zoom In* tool  when using the zoom tool, you can click and drag a box around the area you would like to zoom in to.
2. Use the *zoom in*, *zoom out*, and *pan* tools  to move around the map, and the *Zoom to Full Extent* tool  to go back to the full view – after you have played with these, **Zoom In** to Somerville again.
3. If you can't get your bearings, try clicking on the *Identify* icon () and then click on street centerlines or parks.

4. Can you find *Professors Row* on the Tufts University Campus? Click on the **Find** icon  (docked on your Tools Toolbar), click on the *Features* tab, and type in *Professors Row*, then click on **Find**.



5. A list of results will be produced. Click on one, and you'll see a "flash" at its location on the map – you may have to move the dialog box to see the location, or zoom out your map view. You can also right-click on a result and get different options like *Zoom to* and *Pan to*.
6. Close the Find box.
7. Right-click on *Streetscl* and choose **Label Features** (be sure you right-click on the actual name and not on the line symbol). Labels should appear on some streets.
8. Try zooming and panning again with the labels on.
9. Turn on the *Buildings* layer. If the buildings don't appear, they may be under another layer –layers can block one another, depending on how much area they cover. You can make them draw on top by clicking on the *Building* layer and dragging it up above the other layers in the catalog. This is how you move layers around on a map. Turn the *Building* layer off again for now.
10. When you are done looking around, **right-click on the CityBoundary layer** and choose **Zoom to Layer** – this fills the screen with the Somerville City Boundary area. Note: the CityBoundary layer will not appear itself, however, because it is turned off – you just zoomed to its extent. If you want to see it, left click once on the small box next to its name in the **Table of Contents**.
11. Choose **File → Save**. In the lab, save to the *H: drive under the ArcGIS Basics folder*. Name the map file *basemap1.mxd*. This action creates a *map file* (.mxd). A map file is a very small file that contains pointers to your data sets and remembers what you had up in your session. If you quit ArcMap at this point, the next time you start it, you can choose to start with this existing mapfile and it will automatically pop up all the data layers you added in your first session and with the view of the data just as you left it. Thus, map files are easy ways to save work. But beware - map files do not actually contain the data layers, they only have pointers to the data layers. If you copied your *basemap1.mxd* file and tried to open it on a home computer without the GIS data layers it is referencing (e.g. parks, hydro25k_poly, streetcl), an ArcMap session would start and list the data in the table of contents but nothing would appear because it would not be able to find the data it is pointing to.

Save your mapfile frequently, and always save it at the end of a session!

Defining the General and Symbology Properties for a Layer

In this section of the tutorial, you will learn how to organize your data layers' properties to start bringing some coherence to the map.

If you haven't turned off the labels already, turn them off now by right-clicking on the *Streetscl* data layer and unchecking *Label Features*. This will speed things up while you work.

Assigning proper layer names

First, you need to give the data layers better names than what they have (e.g., *Streetcl* should say "Streets")

1. Right click on the *Streetscl* layer and choose *Properties* (alternatively, you can double-click on the data layer name).
2. When you see the *Properties* dialog box, click on the *General* tab. In the *Layer Name* box, type in *Streets* instead of *streetscl*. Press OK when finished.

Note: this does not change the name of the original data set - it only changes the name as it appears in this session of ArcMap and as it will appear on your final map. If you went back to ArcCatalog, *streetscl* would still be the name used.

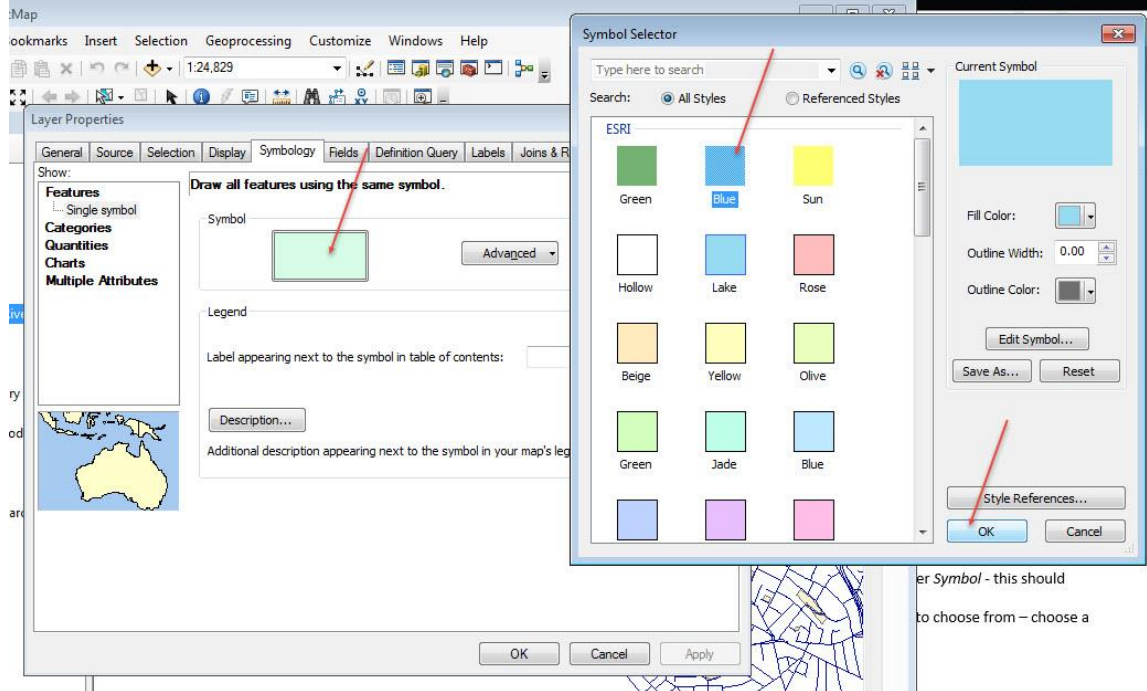
3. Give all the other layers more coherent names as best as you can (e.g. "City Boundary" instead of *CityBoundary*, "Ponds and Rivers" instead of *hydro25k_poly_clip*, "Streams" instead of *hydro25k_arc_clip*). In the future, we will deduct points on assignments for having non-standard English "data-speak" names like "streetscl" appearing in your map

Assigning proper colors

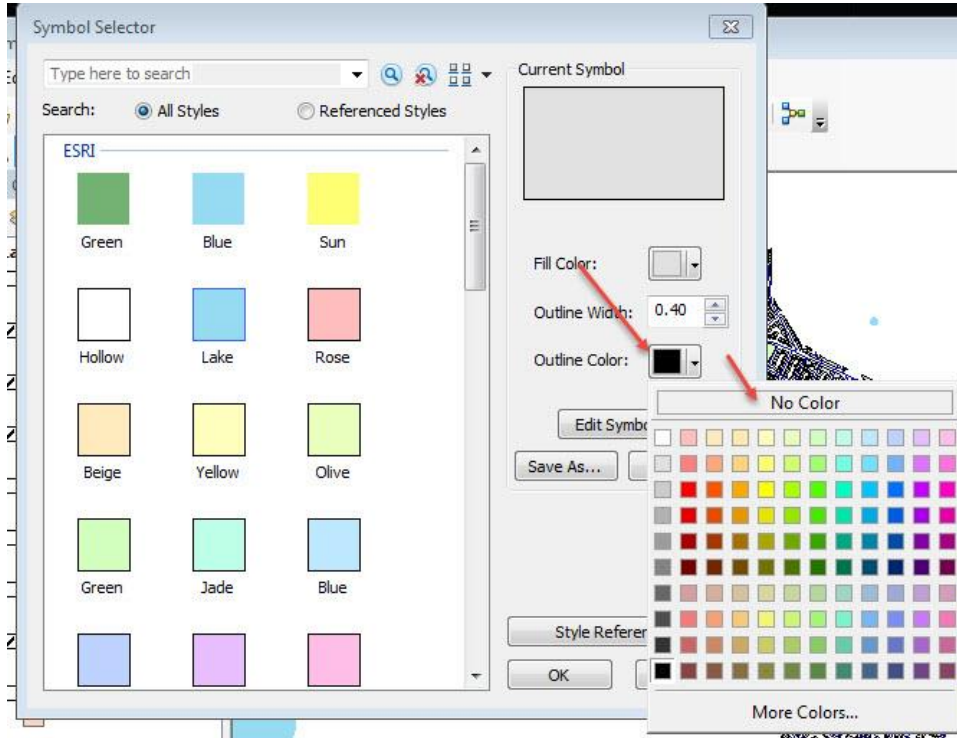
Your map would be a lot better if the water were colored blue, the parks green, etc.

1. Right-click on the *hydro25k_poly_clip* layer ("Ponds and Rivers" or whatever you have called it now) to bring up the *Properties* dialog box again.
2. Click on the *Symbology* tab
3. To change the color of the layer, click on the colored box under *Symbol* - this should bring up the *Symbol Selector* box.

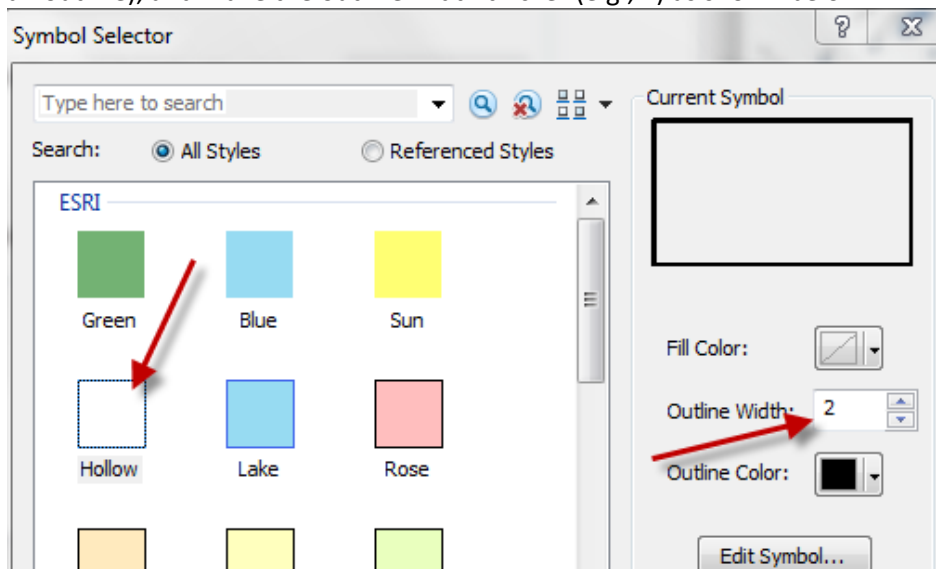
- Click on the small colored box next to *Fill Color*, to see colors to choose from – choose a blue color for water



- Press OK when you are finished, and OK again to return to your map.
- Color the *parcs* layer green.
- Turn on the buildings (left click once on the box to the left of its name in the Table of Contents) and color them a light gray.
 - Note that the buildings still appear fairly black – that’s because the symbology settings have applied a black outline around the gray fill. You (and your map’s viewers) do not need to see these outlines. Turn the outlines off by going back to the layer’s properties and the *Symbology* tab. Once again click on the colored box under *Symbol*. Then click on the small box just right of *Outline Color*, and choose *No Color*. Press OK and OK again to get back to your map. This is how you turn outlines off (you can also change their color or thickness).



- Turn on the *neighborhoods* layer and go to its symbology properties. Use the “Hollow” scheme (no fill color, with an outline), and make the outline width thicker (e.g., 2) as shown below:



- Turn on the **labels** for *Neighborhoods* (right-click on *Neighborhoods* layer and choose **Label Features**).
- Drag the *Neighborhoods* layer to the top of the Table of Contents.
- Using what you have learned, give appropriate colors to your other layers, with the exception of the *Parcels* layer.

A tip for coloring roads: The road centerlines, at least for non-major roads, often look best in a map if they are colored a light gray. That way they show up but won't dominate the map.

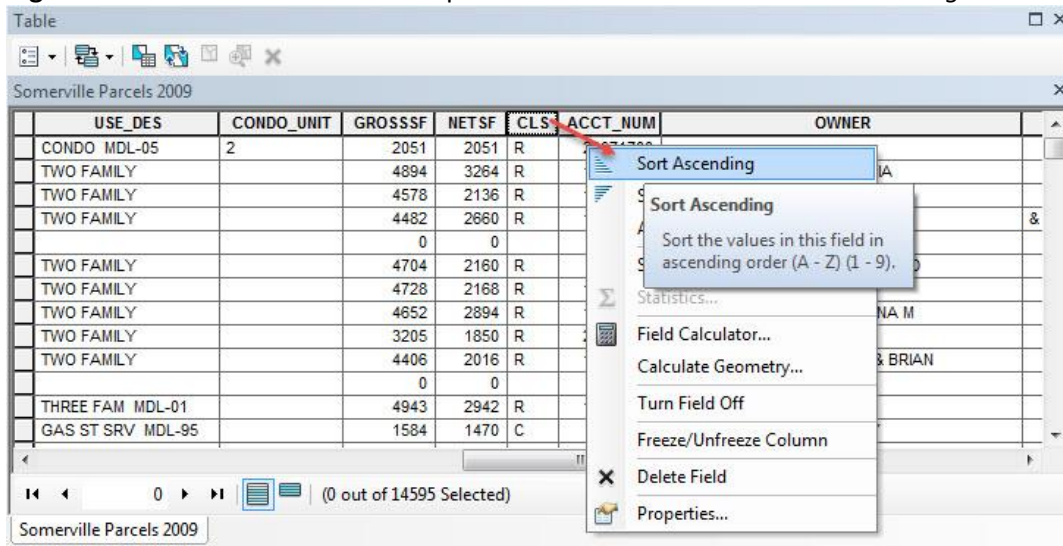
- When finished, choose **File** → **Save** again. Now your *basemap1.mxd* file will remember all the colors and names you have assigned. It's starting to look better....

Drawing a layer based on an attribute value (land use codes)

Some of your layers would look better if you could distinguish between types of features in the same layer. The *Parcels* layer, for example, shows property boundaries but doesn't give us more information when drawn with a single color. You can use an attribute field to symbolize your data to reflect the field values.

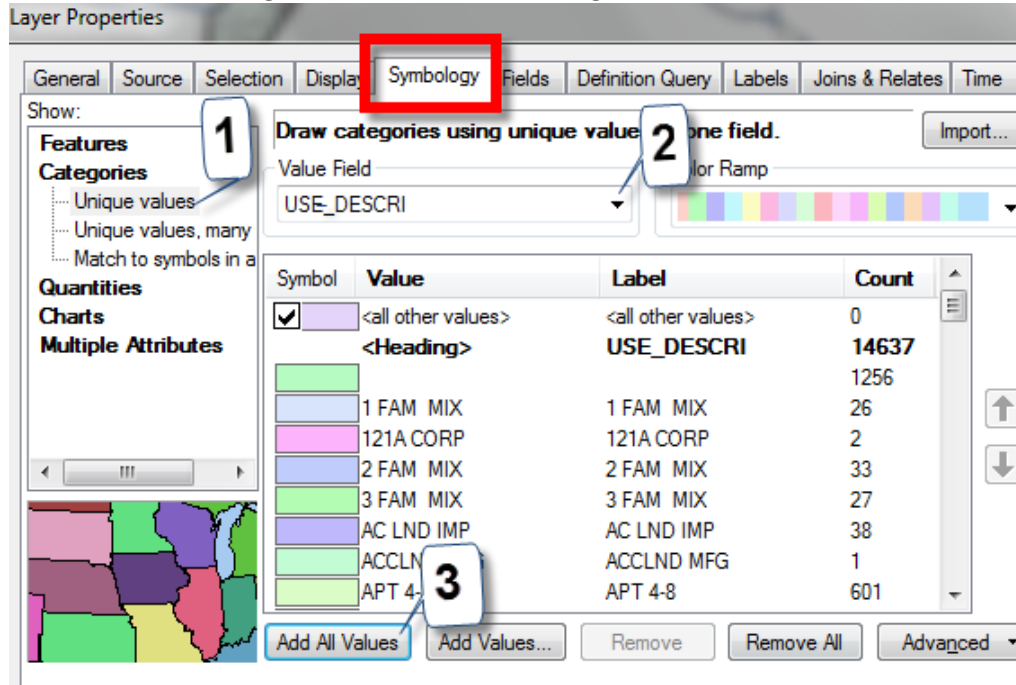
Suppose we want to color parcels by their major type of use (e.g., commercial, residential). The attribute table contains relevant information in this regard, but unfortunately, we have no metadata to explain each attribute column. Obviously, to know what attribute fields are appropriate for use in symbolizing your data, you must be familiar with the attribute table structure, its fields, and the possible values of each significant field. Sometimes this can get confusing because there may be many fields, and the values in those fields are codes with which you are not familiar. This is when metadata becomes very important. Without metadata, you are stuck trying to track down this kind of important information about the data set. Still we can figure out some attributes by looking at the *Parcels* attribute table.

- Turn on the *Parcels* layer so it is visible.
- Open up the attribute table for the *Parcels* layer by right-clicking on the *Parcels* layer name in the table of contents and choosing **Open Attribute Table**.
- Scroll across the table until you see the *Use_descri* (Use Description) field. If you are using the *Parcels 2009* dataset, look for *Use_Des*. Note that there are a number of uses in the parcel data layer.
- Look to the right of the *Use_descri* column and you will see a *CLS* column (in the 2009 dataset, it will be four columns to the right). Look at the values in the *CLS* column and compare them with the *Use_description* column. What do you think the *CLS* values represent?
- Right-click** on the *CLS* name at the top of the column and choose *Sort Ascending* as shown below:



- Scroll through the values, comparing them to Use Description – is it any clearer what the R, C, I, and E represent? Note: there will be several records of “Null” values to initially scroll through.
- Close the attribute table.
- Double-click on the *Parcels* layer to open up properties and click on the **Symbolology** tab.

9. On the left side of the *Symbology* dialog box, click on *Categories*, and then *Unique Values*.
10. From the pull-down menu under “Value Field,” select *Use_descri* (or *Use_Des*).
11. Next, click on *Add All Values* - each unique value in the *Use_descri* field of the attribute table will appear with its own color. Your dialog box should look something like this



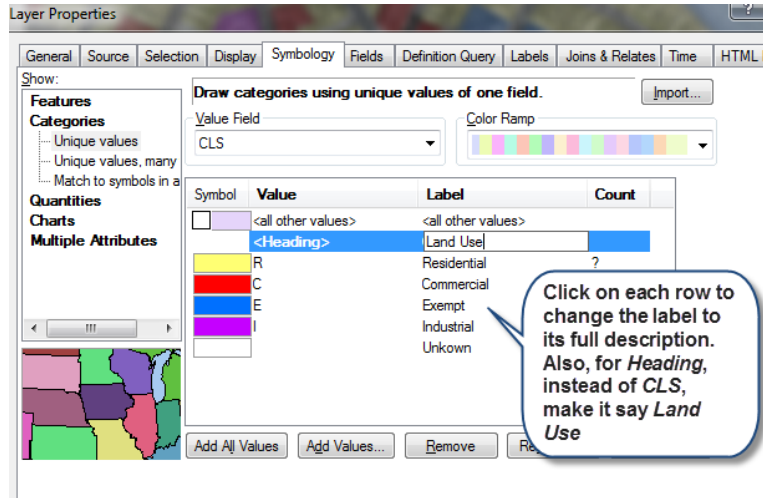
12. Press OK to return to your map.
13. Zoom into an area so you can clearly see individual parcels. You may have to reorder the layers in the Table of Contents to see the change.

This way of coloring by land use is interesting, but there are far more uses than there are colors, so you can't really tell which parcel has which use. This is **NOT** a good way to communicate land use! What might be a better way to visualize land uses?

Fortunately, there is a more generalized land use attribute field in the *Parcels* data layer, as you saw earlier – the *CLS* field. Looking at the attribute table, and knowing something about parcel assessment and planning, we will surmise that the codes are as shown in the table below. The planning profession also has some generally acceptable color standards for visualizing land use that we provide here (see the [APA's Land Base Classification System Level 1 Color Standards](#) for the official recommendations from the American Planning Association):

Code and Use	Standard Land Use Color
R – Residential	yellow
C – Commercial	red
I – Industrial	purple
E – Exempt (meaning the landowners do not pay property taxes, indicating government, educational, religious, or other tax-exempt civic use)	blue

1. Double-click on the *Parcels* layer to get its **symbolology properties** → choose *Categories* → *Unique Values* again, and set the *Value Field* to **CLS**.
2. Click on **Add All Values**.
3. Fill in the dialog box as you see below, changing color and text – note: You can change the name of a category by clicking on it in the *label* column. Set the colors for each category according to the box above. You can do so by individually double-clicking on the colored boxes. Your categories may appear in a different order than shown below.



Note that there was a blank row. That’s because when we chose “add all values” for the CLS field, the software found a lot of blank values. We don’t know what they are, so we call them *Unknown*.

4. You can move the classes around (e.g., to make Residential come first, etc.) by highlighting the class (e.g., R) and using the arrow keys to the right to move it up or down.
5. As you can see, it takes a lot of time to set up the data layers to be colored and labeled appropriately. Save your map file again at this point (**File → Save**) and if you quit now, you would be able to get back to your map session again very quickly, including all your colors and labels.

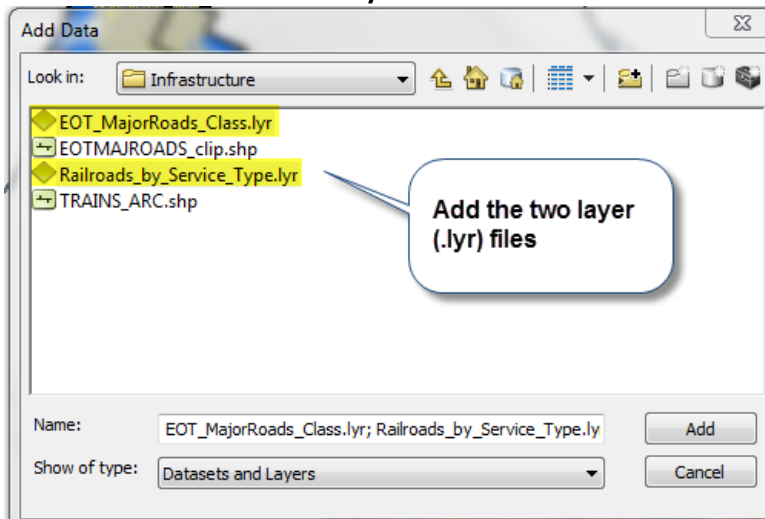
Loading a layer file

Important Note: The following steps may result in ArcGIS crashing and the program closing, so save your map file before continuing (**File → Save**). If the program closes, use *My Computer* to navigate to your saved map file (*basemap.mxd*) and double-click on it. This will start ArcMap again and it will open to where you were. After that, you can repeat the following steps, and it should work fine. This is a good lesson that you should save your map file frequently!

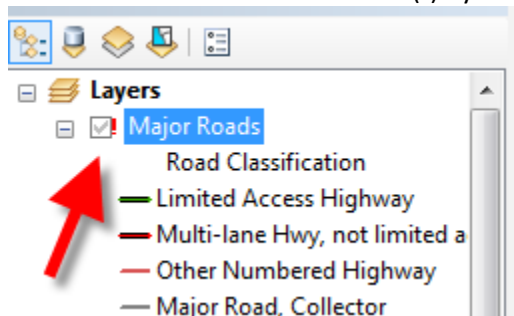
Layer files are special files that contain formatting (color, labels, etc.) for a particular data set. There are two good examples of layer files created by the folks at MassGIS for major roads and railroads. To load these layer files:

1. Click on the add data icon and navigate to the *MassGIS / Infrastructure* folder

2. Add the two files that end in **.lyr** as show below:

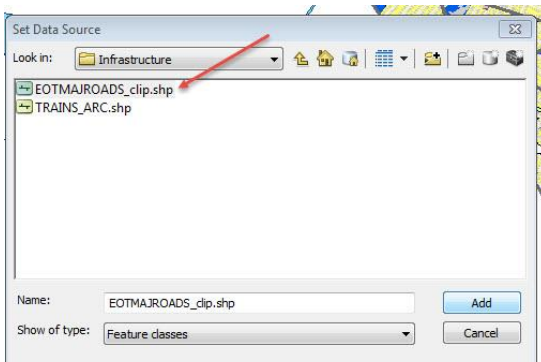


3. You'll see a *red exclamation mark (!)* by Major Roads in the *Table of Contents*:



This means that the layer file cannot find the actual data source (for the major roads, this is the *EOTMAJROADS_clip* shape file).

4. Try turning on the *Major Roads* layer by check-marking it. Turn it off and then turn it on again, which brings up a *Set Data Source* dialog box – in that dialog box, click on **EOTMAJROADS_clip.shp** in the *MassGIS\Infrastructure* folder.
 - a. If a dialog box does not appear, right-click on the layer name (Major Roads) and choose **Data – Repair Data Source**.
5. In the navigation box, look for the *MassGIS/Infrastructure* folder containing the *EOTMAJROADS_clip.shp* file - click on the shape file and **ADD** it. Make sure to checkmark it in the *Table of Contents* to turn it on.



The *Railroads* layer may or may not appear – use the same steps as above if necessary.

You'll see that these layer files include colors, line styles, and labels, including highway shields for the interstate and state routes, and different railroad symbols depending on the current status of the track. These were set by the staff at MassGIS and saved as *layer* files to accompany the GIS data sets. You can have many layer files for one GIS file, displaying the same GIS data in different ways (for example, you could display parcels to show land use or to show land value).

6. Save your *basemap1.mxd* mapfile again.

Labeling a layer based on an attribute field

When you checked the "Label Features" button for streets and neighborhoods, you were using a function that allows you to label features based on an attribute field for the layer. When you use that function, it labels all the features in the map. You can also label features one at a time by pointing to them. First, however, you need to set up the *Label properties* to choose which field you will use to label, font, color, etc.

Before continuing, turn off the MassGIS major roads and railroads, as well as the *Parcels* layers – this will speed things up a bit as you continue to work on your map.

Save your map.

Changing the formatting of labels

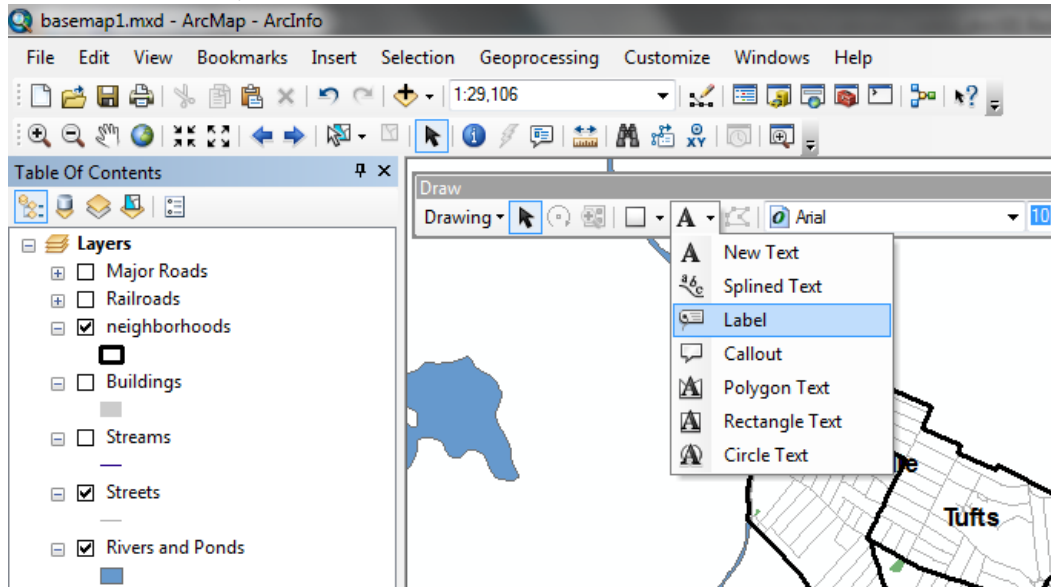
Earlier, you turned on the labels for the *Neighborhoods* layer. Let's say you want to have the *Neighborhood* names stand out more on the map. We can do this by changing the label's format.


1. If the *Neighborhoods* labels are not turned on, turn them on now (right-click on the *Neighborhoods* layer and check *Label Features*)
2. Right click on the *Neighborhoods* layer name and choose *Properties*.
3. Click on the *Labels* tab.
4. Make sure that the *Label* field says *HOOD_NAME*.
5. You can choose the font, size and color of your labels by clicking on the *Symbol...* button – try the Neighborhood name *bold with 12pt font*.
6. When you are done, return to your map.
7. If you don't like the results, adjust the label format again as you wish. Check out some of the predefined label styles.

Interactively labeling particular parks

1. The labels we have been adding are based on attribute table value. Open the *Parks* attribute table (right-click on the layer name and choose **Open Attribute Table**).
2. Look through the table. You will see that a field called *Park_Name* contains the park name. We want to use this field for labels.
3. Close the table, and open the layer properties of *Parks*.
4. Click on the *Labels* tab.
5. Make sure that the *Label* field says *Park_Name*.

6. Using the same steps as before, make the park name *italic*.
7. When you are done, return to your map.
8. No labels appear yet. Try labeling all the park features at once by right-clicking on the layer name and choosing *Label Features*. This turns the labels on. There are a lot of labels and this makes for a rather messy map. We want to label only the largest parks.
9. Turn off the *Label Features* function.
10. Click on the *Parks* layer in the *Table of Contents* and **drag** it up so that it is at the **TOP** above the other layers.
11. To label features interactively (one by one) you need the *Draw* toolbar. Choose **Customize -Toolbars**, and click on the *Draw*.
12. In the *Draw* toolbar, click on the arrow nest to the "A" icon and then the *Label* icon as shown below:




13. A pop-up box appears on screen – you can ignore this for now but note that it is set to use the label properties you just defined.
14. Click on a larger park. The label will appear. (Note: if you accidentally click on another feature like a street, its label will appear instead – zoom into the map if you need to get a better view of a park). If needed, click the Edit toolbar at the top of the screen, and then *Undo*.
15. Label some other large parks.
16. Close the interactive labeling box when you're finished.
17. You can move or delete a label by selecting it with the "select elements" icon  on the Tools menu. To move it, click on the label with the pointer icon (this selects the label) and move it to where you want it. To delete it, select the label and press the delete button.
18. Close the *Draw* toolbar for now or just drag it out of the way.
19. Save your mapfile when you're finished.

Measuring features and drawing a map to scale

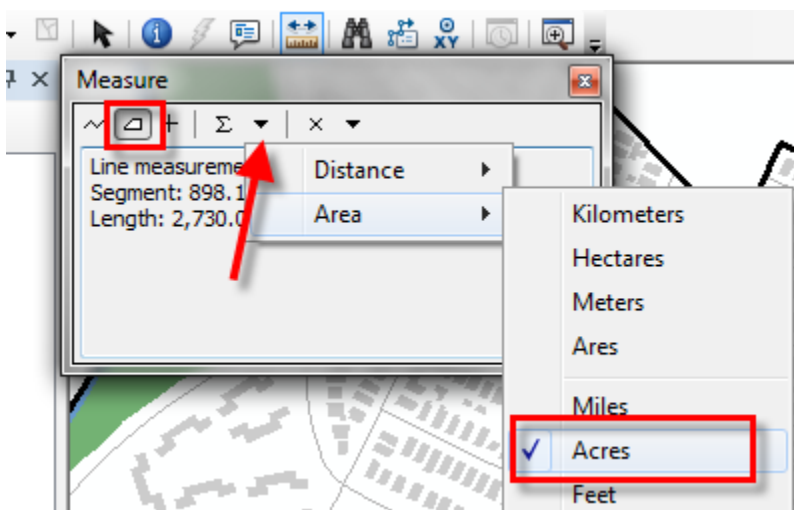
Making measurements and scaled maps is a very important GIS function.

Measuring distances and areas

1. Click on the **Measure** tool in the *Tools* toolbar. 
2. Click somewhere on the map to start a measuring line. Drag the line somewhere else and click again. You will see two measurements reported in the Measurement window. The first, *segment*, gives the distance (in *meters*) of the line you just drew. The second, *Length*, gives the total distance. Click on a third point in the map. You will see the new segment distance plus the total distance of both segments. Double-click on the map to stop measuring (or choose a different tool).
3. If you want to measure in a different unit, click on the little black triangle as shown below and select a new distance unit:



4. Try calculating the area in acres of the Somerville section of the Tufts campus (turn on the buildings to help guide you) – use the polygon tool in the *Measure* tool as shown below and set the area units to acres:

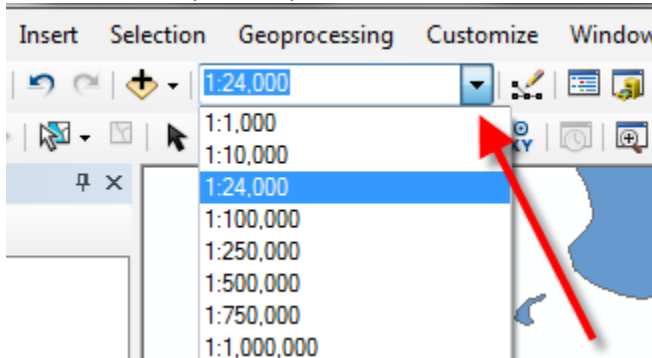


Hint: If you want to measure a new area or length, close the measure tool and open it again.

Drawing a map at a set scale

Many professional map users expect printed maps to be at a standardized scale. USGS topographic maps are printed at 1:100,000 scale (1 inch on the map equals 100,000 inches in the real world or about 1.58 miles) and at 1:24,000 scale for example (1 inch on the map equals 24,000 inches in the real world, or 2000 feet or about 0.38 miles). In ArcGIS you can scale your map to any scale, but you are also offered standard scales from which to choose.

1. Set the scale of your map to 1:24,000:



2. Experiment with some of the other map scales. Which scale would be good for a detailed map of East Somerville or the Tufts campus? What about for a study of transportation in metropolitan Boston?
3. Try typing in 12000 in the scale box – this creates a map at 1:12,000 scale (1 inch on the map equals 12,000 inches in the real world, or 1000 feet).

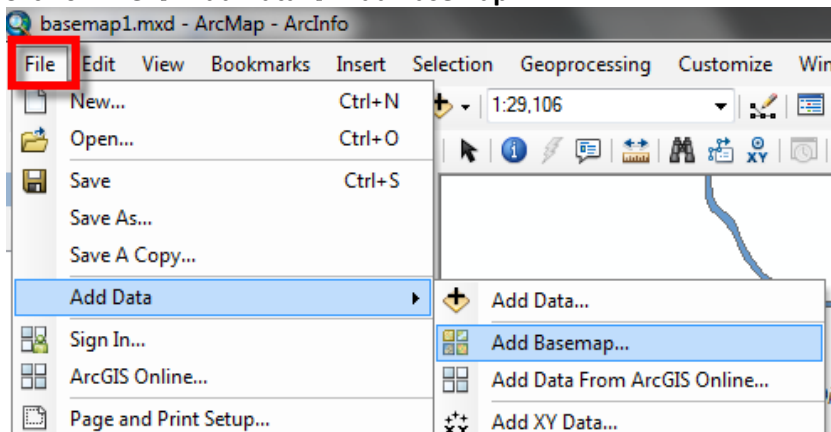
It's important to start becoming familiar with map scales. You have been using what is called a unitless scale – e.g., 1:24,000 means 1 of any unit on the map (inches, centimeters, feet) equals 24,000 of those same units in the real world.

Using Data from ArcGIS Online

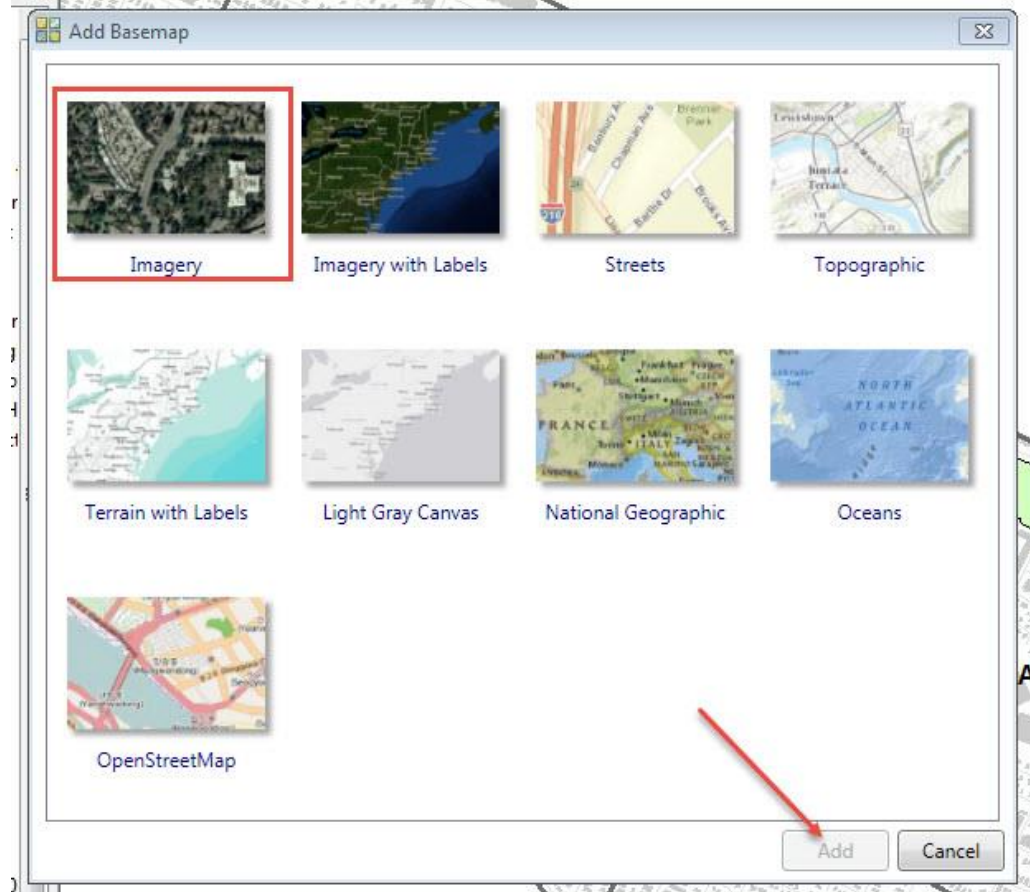
Note: the following task will sometimes not work, most likely due to server issues. If it fails, try it again. Also be sure to save your mapfile before starting the next step because ArcMap may crash.

Increasingly, ESRI and city and state agencies are setting up online GIS data servers that you can access from ArcGIS. We're going to use some of these services now, adding imagery and a basemap.

1. Click on **File** → **Add Data** → **Add Basemap**:



2. Click on **Imagery** and then **Add**:



It will take a few moments to load the imagery.

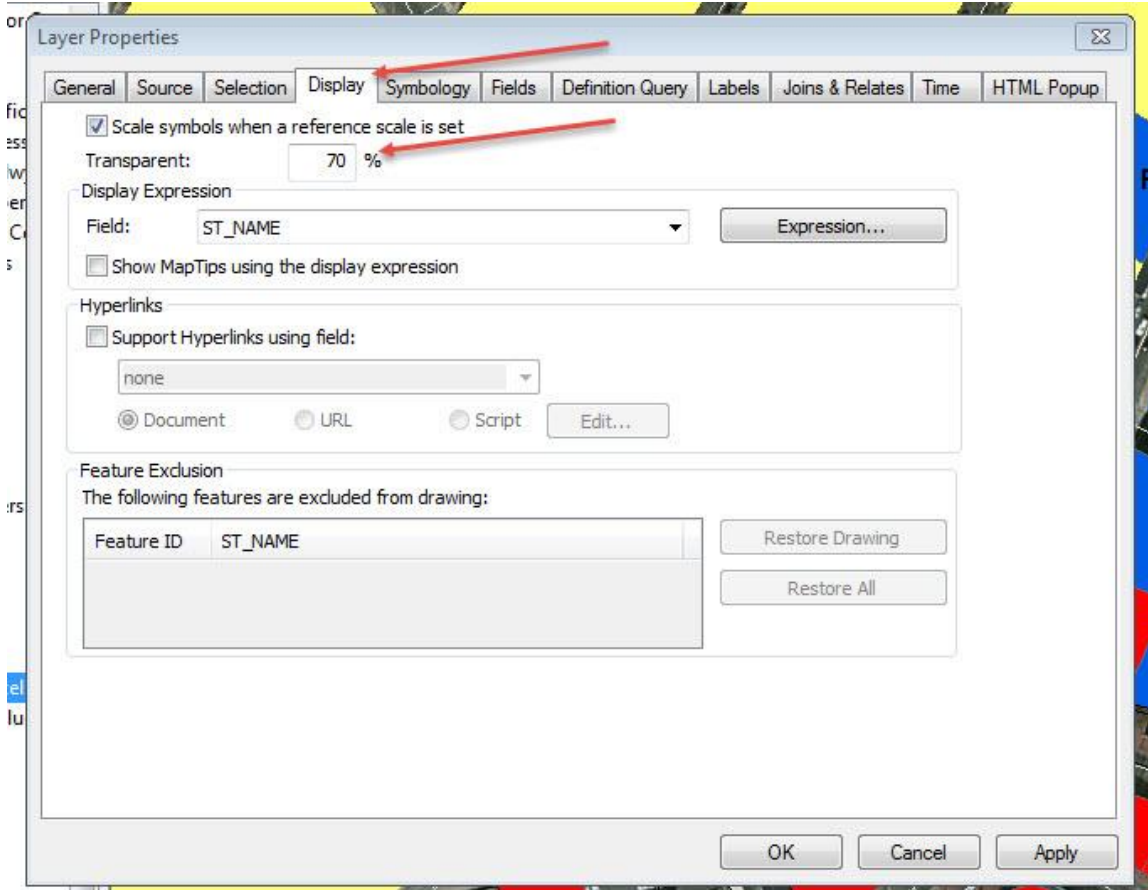
3. You'll get a warning about the *geographic coordinate system* – click **Close** on that warning for now. Click **Yes** if you get a warning about the Hardware Accelerator.
4. Be patient – the imagery will take a while to draw!
5. Once you see the imagery, try zooming into a small area, like the Tufts campus or a few buildings. You'll see that it takes a minute but that the imagery will sharpen.
6. Turn off the imagery for now (it will be listed in the Table of Contents as **Basemap**).
7. Click on **File** → **Add Data** → **Add Basemap** again, and this time choose **Topographic**.
8. Once the Topographic map appears, try comparing it with some of your other map layers. What are the advantages of using this *Topographic map service*? Do you see any disadvantages?

Making data layers transparent

Suppose you wanted to show land use by category over aerial imagery. You can display layers above the aerial imagery or shaded relief to be somewhat transparent if you like.

1. Turn off the *Topographic map service*.
2. Turn on the *Imagery* again.
3. Turn on the *parcels* (they should still be colored by general land use).

4. Zoom into Davis Square or Tufts University or Union Square.
5. Right-click on the parcels layer and open its properties.
6. Go to the *Display* tab. Set the *Transparent* entry to 70% and press *OK* to see what happens (it may take a while to draw).

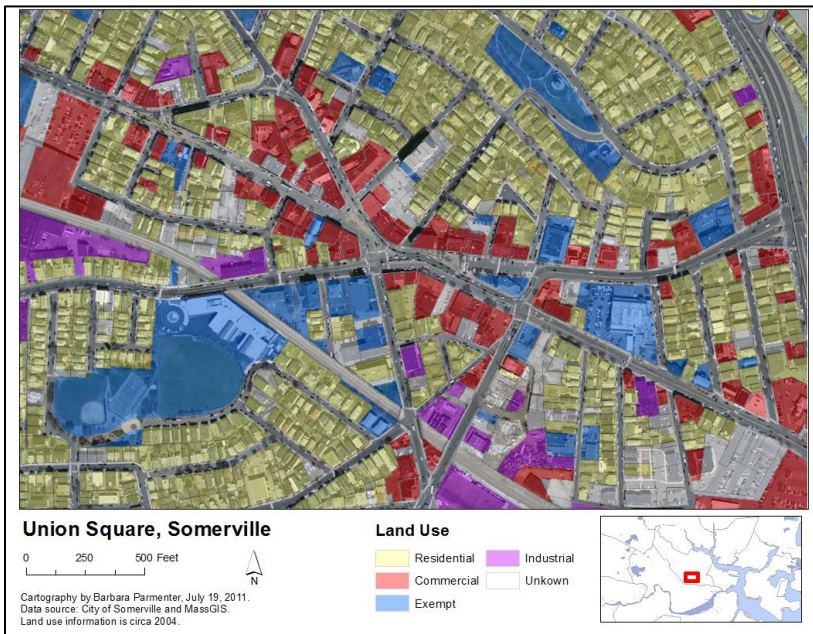


7. When you're done experimenting, save your mapfile again.

Creating a map for printing or exporting as a digital graphic

Now you're ready to create a well-designed map. But please read the following first....

When you create a map, you should include the map itself, plus a title, a legend, a scale, and a north arrow. You should also provide the name of the cartographer (you), a date, and acknowledgements about data sources. Here is an example of a complete map:



It is important in a map not to include too much information. You would not want a map that includes all the data layers you have in your ArcMap session from this tutorial. It would be much better to do several maps, e.g., one showing the general layout of Somerville with streets and parks, another showing land use, possibly one showing the buildings in black with all the other space blank (this is called a Nolli map by urban designers and is used to explore a community's built fabric).

You may also include other elements on your map, for example, more explanatory text, charts, tables, photos, or other images.

Note that you can also have more than one more than one data frame on a layout – for example, you can have a small locational reference map (as in the map above) or an inset map to show an area in more detail. See the next section (*Adding a data frame to show two or more maps on a layout*) for instructions about how to do this.

To do all this, you will move into **Layout View**. *Layout View* is much like viewing the page layout when you are working in a word processing software. You should do all the preliminary work and analysis in the **data frame view** (where you have been up to now in this tutorial), then move into *Layout View* only when you are ready to create a map.

For detailed information about layouts, see *Help – ArcGIS Desktop Help – Professional Library – Mapping and Visualization – Page Layouts*.

If you don't already have it open, start ArcMap and bring up your map file from the earlier part of this tutorial.





Setting up a map layout

1. Before you start a map layout, it is important to think through what you want to do and how you want your map to look. What do you want to show? How large do you want your final map to be? Portrait or landscape orientation? Do you need space for additional text or graphics? This tutorial example will assume a paper size (8x11 inch) map but often you are making map for publications where they must be smaller, or for Powerpoint where they need to be a certain size (e.g., 7.5x10 inches), or for posters where they may be much larger than 8x11.
2. In ArcMap, choose **View → Layout View** from the main menu.

3. The view changes to show your data frame on a page layout and a new toolbar appears – the *Layout* toolbar.
4. The first thing you should do is to set up your Page properties. Choose **File** → **Page and Print Setup**.
5. In the *Page Setup* dialog box, make sure that the page size is set to *Letter*. Also check either *Portrait* or *Landscape* (which would be better for the map you want to create? The example map is in *Landscape* orientation). Press OK to return to the map.

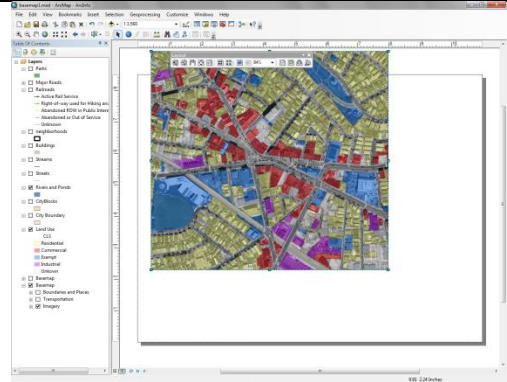
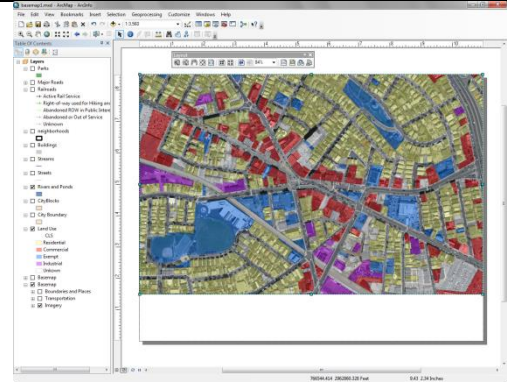
Moving around in the page and data frame

It is very important to understand the difference between the **Layout** toolbar and the regular (data frame) **Tools** toolbar. They share similar tools (zoom in and out, pan) but the **layout tools** work on the layout as if you were zooming in and out of the *paper itself*, while the same tools on the **Tools** toolbar work on the data inside the data frame (e.g., zoom into Davis Square). You will get confused occasionally, but once you get the hang of the two toolbars, you will be off and running. For now experiment with both to see what happens.


<p>The Tools Toolbar</p> 	<p>The Layout Toolbar</p> 
<p>Use these to navigate within the <i>data frame</i> on your map (e.g., you want the data frame to be slightly more zoomed into Davis Square, or you need to pan the data frame to the north).</p>	<p>The 1:1 tool  is particularly useful to see what the map features and text looks like at actual print size.</p> <p>The Zoom to Whole Page tool  will take you back to the entire page view.</p>

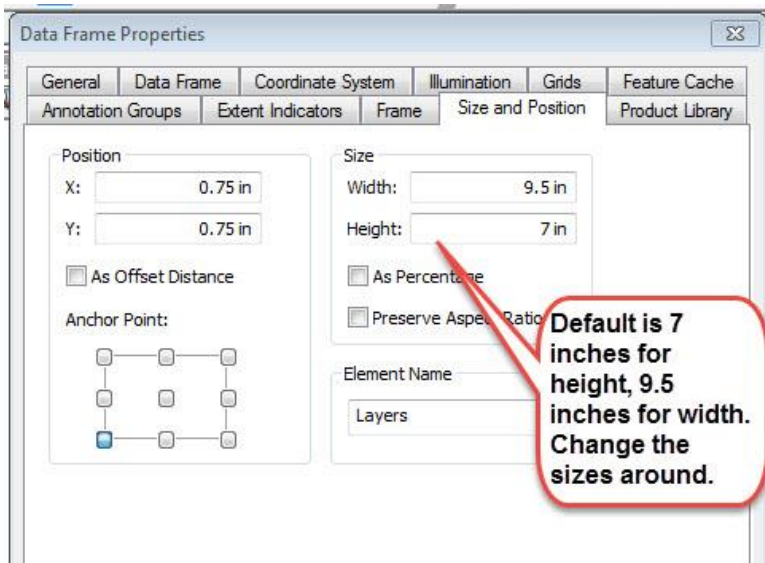
Resizing and moving the data frame

You will always need to re-size things in your map, especially the data frame itself which contains the map image. On the left below is something you might see when you first start a layout. In this case we are moving and resizing our data frame so that it fills the upper 4/5ths of our page. We'll then put a title, legend, and other map requirements in the blank space along the bottom of the page:

<p>Data frame and layout page not adjusted</p> 	<p>Data frame after resizing and moving to fit the layout page</p> 
--	--

Moving and re-sizing in ArcMap works similarly to most other programs where you use graphics. The key is selecting the element first.

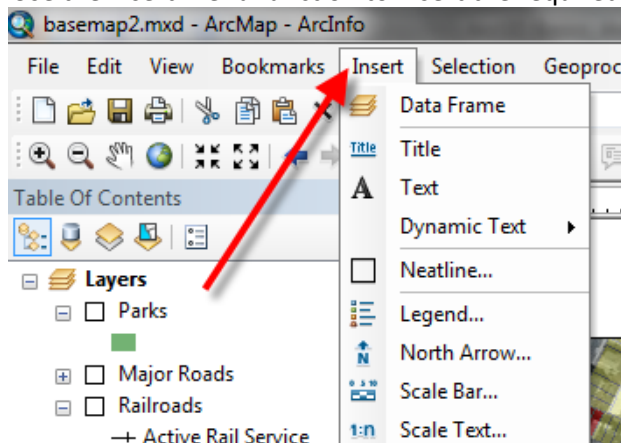
1. To resize and move the data frame, use the **Select Elements** pointer  to select the frame first.
2. Use the small grab points on the corners and sides to resize.
3. Place the cursor anywhere over the data frame to move it.
4. Alternative: With the frame selected, right click and select Properties→Size and Position. You can adjust the size of the frame here. If you switch the sizes in the width and height boxes, the data frame will appear in landscape format.



Inserting a title, north arrow, and legend

These are all usually required elements on a map. You access them by going to the **Insert** item on the *main menu* bar. You can read more about these by going to *Help - ArcGIS Desktop Help – Professional Library – Mapping and Visualization – Page Layouts*, but here are a few tips:

Use the *Insert* menu function to insert the required map elements:



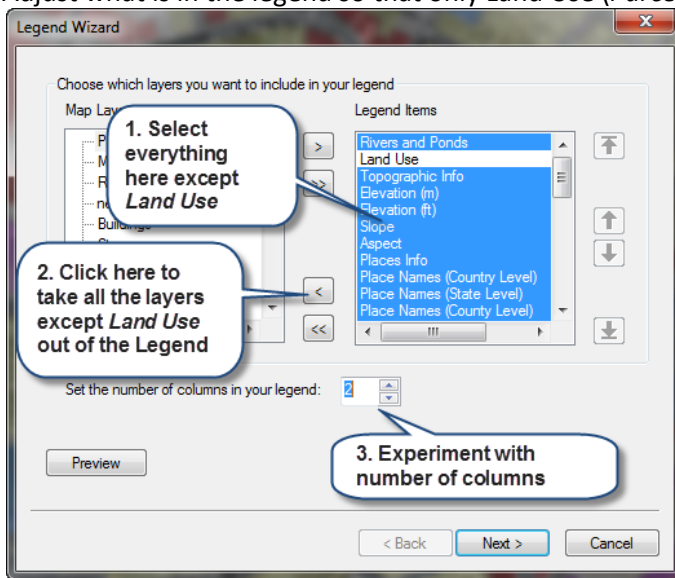
Insert Scale Bar

The scale bar you select will be in the *Display* units of your data frame (e.g., feet). If you want a different unit, double-click on the scale bar. In the *Scale Line Properties* dialog box, select a different *Division Unit*.

Insert Legend

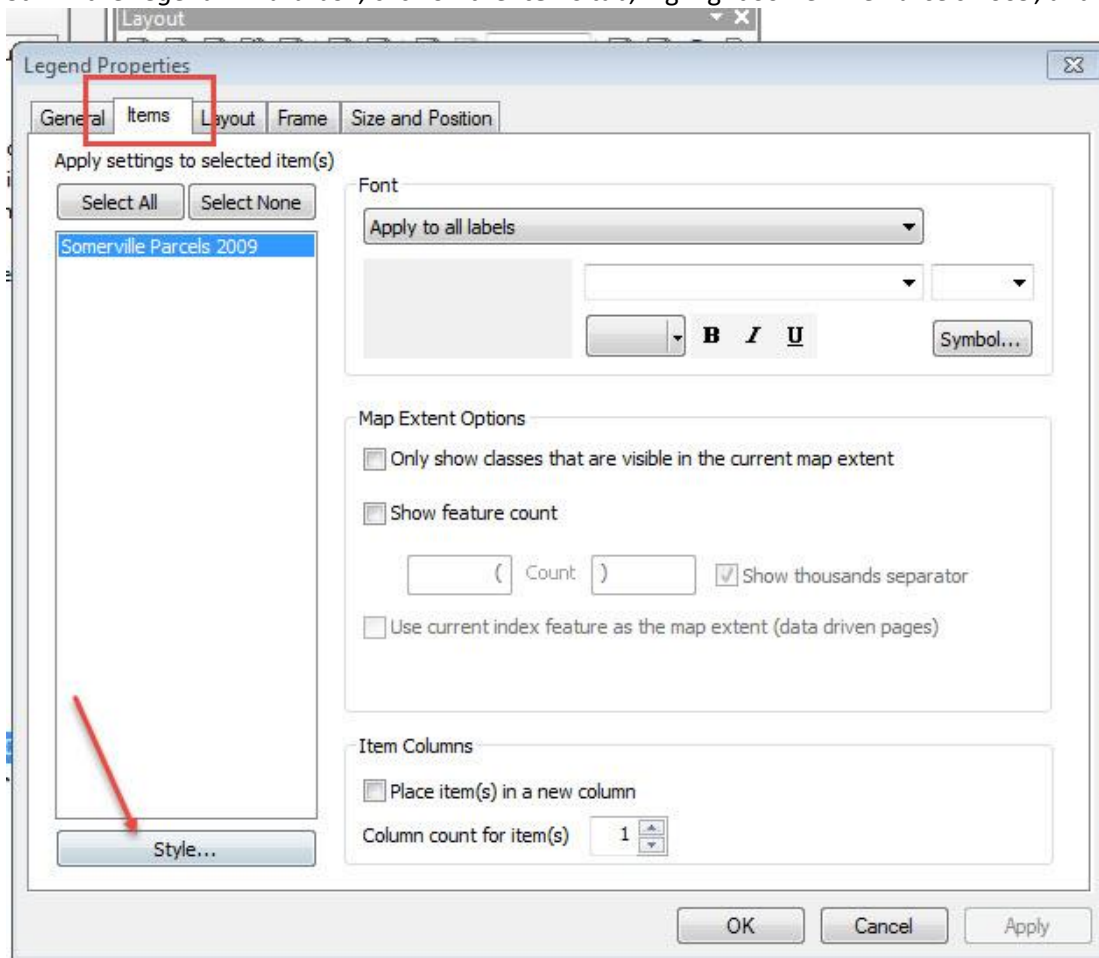
There are lots of ways to improve your legend. For starters, let's say we're creating a land use map. We want the legend and map to focus on land use. We have imagery in the background as in the example map, but everyone knows what that is, it doesn't have to be identified in the legend. To control what goes on the legend:

1. Choose **Insert** → **Legend** from the main menu.
2. Adjust what is in the legend so that only Land Use (*Parcels*) is there:

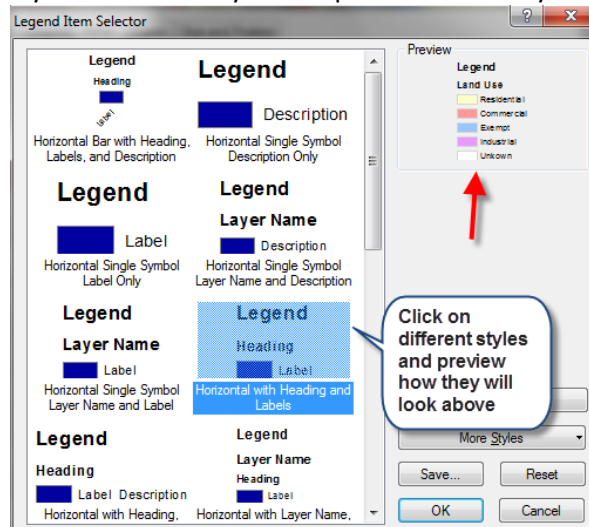


3. Click the "Next" button, noticing the different settings options, until you get the option to click Finish.
4. You can modify an existing legend by double-clicking on it to bring up the legend properties. For example in the Legend Properties, you can tell it NOT to show the word "Legend" or you can change that word to something else. Notice these settings were available when you inserted the legend, but you can access them again here.

- Still in the *Legend Wizard* box, click on the **Items** tab, highlight *Somerville Parcels 2009*, and then click on **Style:**




- Try out different styles and preview how they will look:



- Press OK, and OK again. If the map goes back to one column and you want two, double-click on the *Legend* again and under the *Items* tab, type in 2 for *columns*

Selecting Elements

Remember, you always have to select an element before you can move, resize, or change its properties. Use the select pointer icon  on the *Tools* Toolbars.

You can select more than one element by holding down the CTRL key as you click on each element.

Modifying an element after insertion

You can usually modify an element after you have inserted it by selecting it and then double-clicking on it. The relevant dialog box will appear for that element (e.g., title, legend, scale bar).

Inserting text

To put in your name as the cartographer, and any other information, use the **Insert -Text function**. Remember also to include a date. You should also have a data source note that the data comes from the City of Somerville and MassGIS.

Add more text for any more descriptions or explanation.

You can change font properties on selected text by right-clicking on the selected text and choosing Properties.

Inserting a Picture

Note that you can also insert images into the data frame.

Deleting and trying again

If modifying an existing element doesn't work, remember that you can always select an item and delete it if you don't like it. Select it using the select pointer, and press *delete*. Especially useful if your legend gets messed up - just delete and insert a new legend again to start fresh.

Extent

If you accidentally move the extent of your map, you can use the pan (the hand) tool or the back button to return to your desired location.

Saving map files under different names

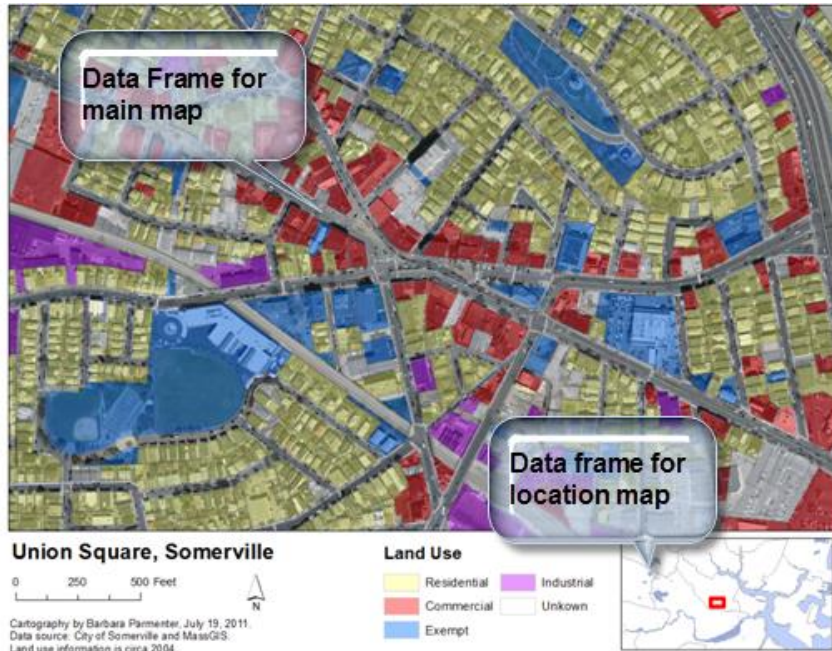
Once you have created one map in a layout you like, you can save your map file (File – Save As) to be the name of that map (e.g., Somerville Land Use). You can then use the same layout but change some of the visible features and save as a new map name (e.g., Somerville Streets, or Somerville Parks).

This allows you to make maps fast once you have a good layout, and it allows you to make maps of the same area at the same scale, but showing different layers of information.

Choose **File → Save As** now and save the map file to an appropriate new name.

Adding a second data frame to show an inset map

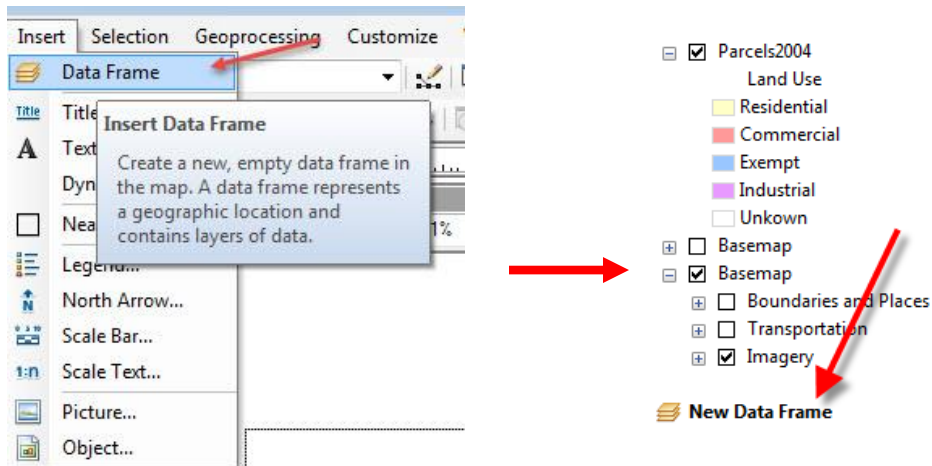
You can add a second (or more) data frames to your ArcMap session. Only one data frame will appear at a time in the data frame view (right-click on the data frame name and choose Activate to see the data frame you want). But in the layout, all the data frames will appear. This can be handy for putting in a small "locator" map as in the *Land Use Map* example:



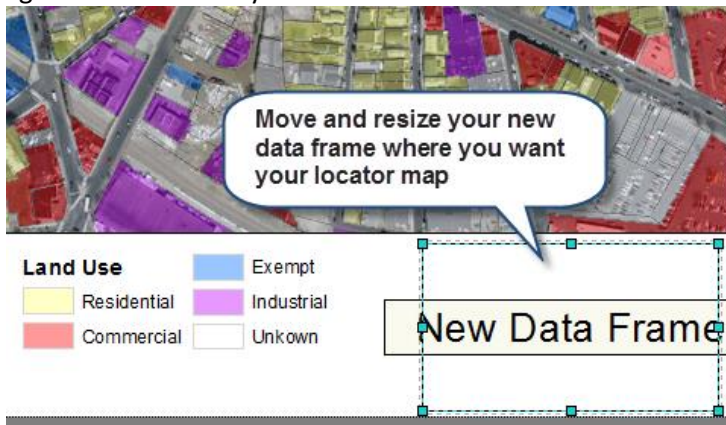
Adding a second data frame for a locator map

Multiple data frames can get a little tricky, and will take some practice. Play with them some, and remember to save map files frequently under different names in case you mess up and want to return to a previous view. In this example, we'll use a new data frame to insert a locator map.

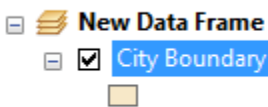
1. In *Layout View*, choose **Insert** → **Data Frame** from the main menu – a *new data frame* box appears in your layout. You'll see *the New Data Frame* listed in the table of contents:




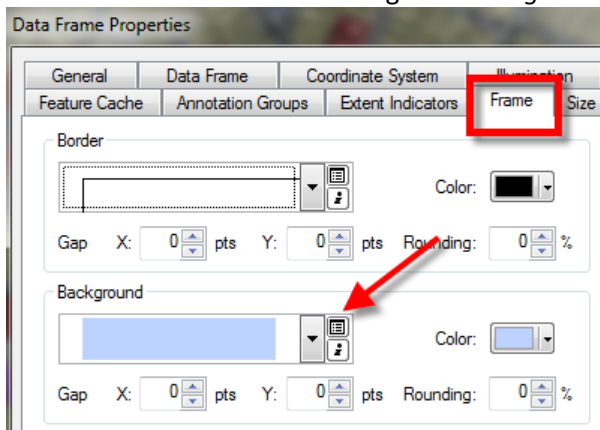
2. Move and resize the *new data frame* box so it is in the location you want it – here we are taking it to the bottom right corner of our layout:



3. You can add data to this data frame just as you did to the first one, or in the *Table of Contents*, you can drag a layer from the first frame to the second. Try dragging the Somerville **City Boundary** layer from the original data frame (called *Layers*) down to the *New Data Frame* and turn it on



4. Use the **Add Data** icon  to add the data set *TOWN_POLYM* from the tutorial data set under *MassGIS\Political_Boundaries* – these are town boundaries for all of Massachusetts.
5. Make sure to drag the town boundaries below the Somerville City Boundary.
6. Make the *TOWNS_POLYM* fill color white with a gray outline.
7. In the *table of contents*, right-click on **New Data Frame** and choose **Properties**
8. Click on the **Frame** tab and change the *Background* color to blue – this will make the water appear blue.

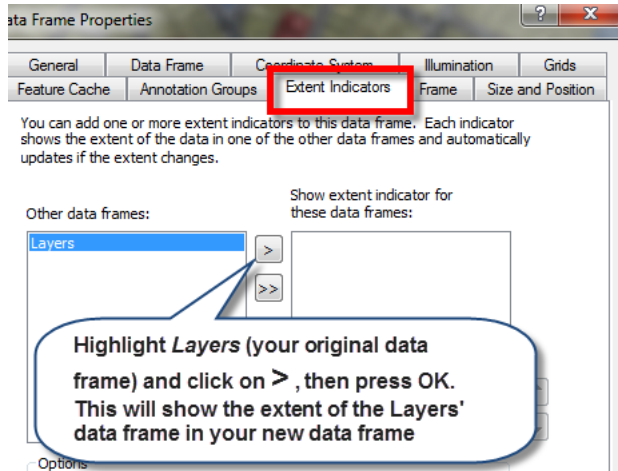


9. Press OK to see the results.
10. Save your map file!

Setting up locator map boundary box

Finally, we're going to show a boundary box on our *Locator Map*.

1. Right-click on the *new data frame* to get its *Properties* dialog box back.
2. Click on *Extent Indicators* tab and follow the instructions below, then press OK:



3. If all this was successful, save your mapfile! Otherwise delete and try again.

Printing or exporting your map

To print, you must export to a digital graphic format like .pdf. Printing works just like any other Windows program, so we won't cover that here, but feel free to print your map.

The ability to **export** to a digital format is very useful. If exporting to an image, remember to set your page size to the appropriate dimensions - this may mean custom dimensions, e.g., a small image to fit on a computer screen, a powerpoint presentation, a web site, or word document. When creating a layout for digital export, you should think ahead about what size you want your final image and lay out the map accordingly, and be sure to use font sizes that are readable at the final map size.

1. When you have your layout the way you want it, choose **File → Export Map**.
2. In the *Export* dialog box that appears, navigate to your tutorial folder and give the image a name.
3. For *Save as Type*: choose a format - we recommend **.gif or .pdf format** because they come out well and are readable across a variety of platforms. The only problem with PDF formats is that they do not recognize all text fonts, so stay simple with your font types - e.g., Arial or Times New Roman.
4. **Before you export**, adjust resolution under the **Options** area. Digital images meant to be seen on a computer screen do not need high resolution. 96 or 150 should be fine depending on image size, 300 should be the maximum.
5. Press **Export** when you are ready to go - the process will take a minute.
6. Check your results by navigating to the folder outside of ArcGIS and opening the graphic - if not pleased, experiment with different resolutions and compare file sizes.

That's the basics. Now practice what you have learned by creating several maps showing different aspects of the Somerville area.