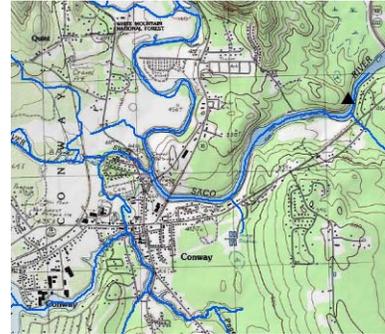


# Introduction to ArcMap for Water Resources Data

Barbara Parmenter and Jack Melcher, revised: 9/15/2011



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## Introduction

This tutorial introduces you to ArcMap 10, the GIS software program that we use at Tufts, and shows how to map relevant watershed data for a watershed of your choosing. Part of this tutorial involves acquiring data from a government data service for a stream gage and watershed of your choosing. Once requested, the acquisition process may take up to two days, so plan accordingly. A more typical time frame is an hour or two, but heavy use of the site may delay data delivery.

If you wish, you can use a set of data that we have already downloaded for this tutorial – the data is located on the GIS Center’s network drive at S:\classes\CE

0112\_Hydrology\_Water\_Resources under the *Tutorial1\_Data* folder. The data are for HUC subbasin 01060002 which straddles the New Hampshire/Maine border.

*Mozilla Firefox* is recommended for use in this tutorial. *Microsoft Internet Explorer*, as configured in the computer labs, blocks the download of files from USGS.

Data management for this tutorial:

- Make a **HydroGIS** folder with the following subfolders: *Data*, *Temp* – **Note:** if you're in the GIS Lab, we suggest you use the H: drive
- Save your work frequently! ArcGIS tends to crash periodically, and there is no AutoSave feature.

### Choosing a HCDN station for watershed mapping

Open a web browser and go to the *Hydro-Climatic Data Network*

(<http://pubs.usgs.gov/of/1992/ofr92-129/content.html>)

1. Click on link for *HCDN Streamflow Data*
2. Choose a *region*
3. Choose a *station name* and in a text file, copy and paste the *Station Number*, *station name*, *HUC code*, and the *latitude* and *longitude* - look for a drainage area (DA) between 10 and 500 square miles  
e.g. [01064500](#) SACO RIVER NEAR CONWAY, NH 01060002 43:59:27N 071:05:29W  
(**Note: use the above station information if you are using our pre-downloaded data sets**)

### Downloading Data from the National Map

**Note: if you use our pre-downloaded data sets, you should skip this section and proceed to Section 4. The data sets are on the GIS Center's network drive S:\classes\CE 0112\_Hydrology\_Water\_Resources under the *Tutorial1\_Data* folder**

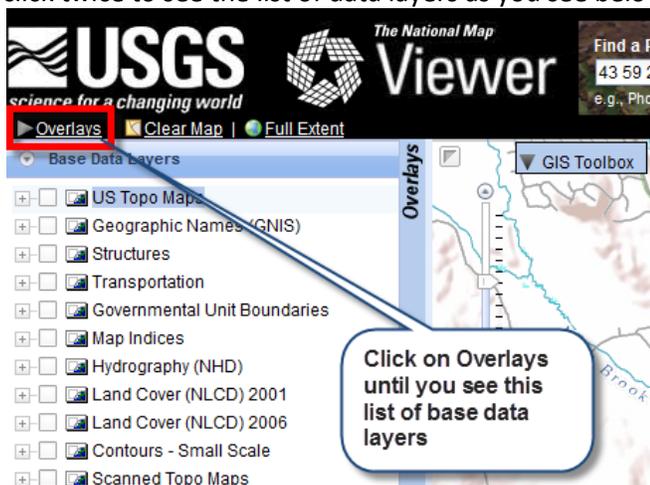
You will now download GIS data from the *National Map*, an online mapper and data distribution program from the USGS. In this section of the tutorial you will be downloading the following data sets for the hydrologic subbasin (HUC 8-digit basin) in which your stream gage lies:

- The *National Hydrography Data* set (NHD – includes flow lines, water bodies, stream gages, and many other hydrographic data layers)
- A *Digital Elevation Model* (DEM - shows elevation and allows for watershed delineation and other hydrologic analysis)
- 2006 *landcover* (*National Land Cover Data, or NLCD*)

1. Open a web browser (preferably Mozilla) and go to the **National Map** web site (<http://nationalmap.gov/>)
2. Click on the link for *National Map Viewers* and select the current viewer:



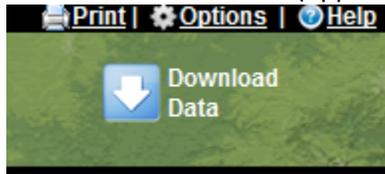
3. Search for the coordinates of your selected HCDN stream station name (but now written as: 43 59 27N 71 05 29W (i.e., latitude comes first, no colons)
4. You will be zoomed into your stream gage point
5. In the *top left corner*, click on **Overlays** to open the *Overlays panel* (you may have to click twice to see the list of data layers as you see below) :



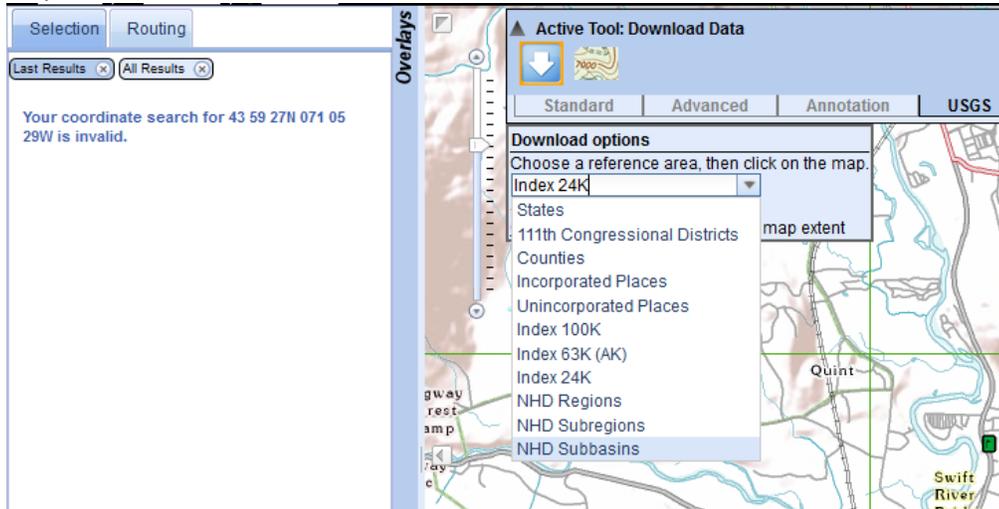
6. Expand *Reference Polygons* (click on + sign next to it)
7. Expand *Hydrologic Units*
8. Checkmark *Subbasins* to turn that layer on
9. You should see the HUC Code label come on the map - make sure it matches the HUC code from the HCDN station name that you recorded above



10. Click on **Download Data** (upper right corner of screen)

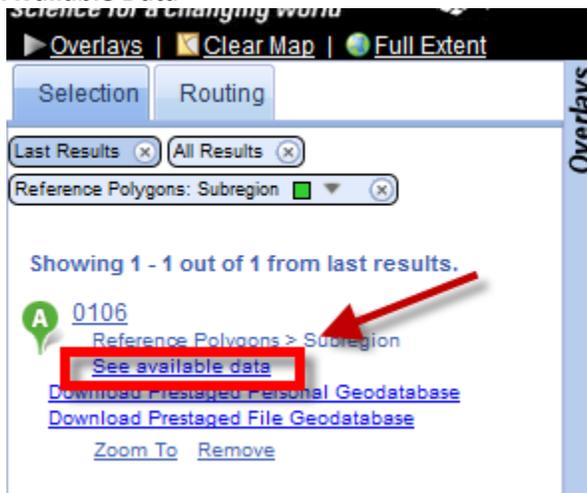


11. For *Download Options*, choose a reference area - select *NHD Subbasin* from the dropdown menu



12. Now click on your map near your stream gage

13. The resulting subbasin should appear in the selection results window – click on **See Available Data**



14. Checkmark *Hydrography, Land Cover, and Elevation*



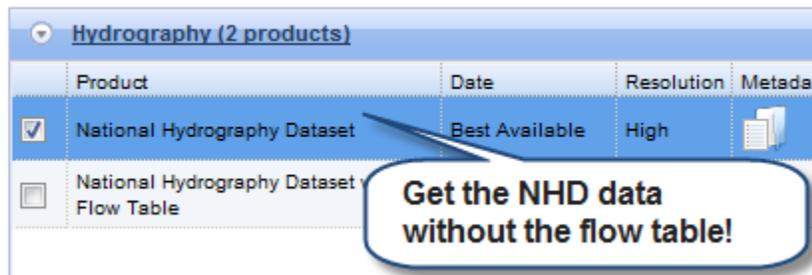
The following themes and products are available for download in the polygon you selected. Check one or more and click 'Add to Cart.' Products will be added to the Cart on the right side of the screen.

Selected item type: **NHD Subbasins**  
 Selected item name: **HUC: 01060002**

Theme	Format
<input type="checkbox"/> <a href="#">US Topo</a>	No bulk download option available
<input type="checkbox"/> <a href="#">Structures</a>	File Geodatabase 9.2
<input type="checkbox"/> <a href="#">Transportation</a>	File Geodatabase 9.2
<input type="checkbox"/> <a href="#">Boundaries</a>	File Geodatabase 9.2
<input checked="" type="checkbox"/> <a href="#">Hydrography</a>	File Geodatabase 9.2
<input checked="" type="checkbox"/> <a href="#">Land Cover</a>	GeoTIFF
<input checked="" type="checkbox"/> <a href="#">Elevation</a>	GeoTIFF
<input type="checkbox"/> <a href="#">Orthoimagery</a>	GeoTIFF

15. Click on **Next**

16. In the next dialog box, *select the layers* you see below clicking on Next each time you choose a data set:



Land Cover (6 products)							
Product	Month	Year	Type	Resolu	Units	Meta	
<input type="checkbox"/> Database 2001 V2 - Land Cover	Availat	Availat	Cover	30	Meters		
<input type="checkbox"/> National Land Cover Database 2001 V2 - Impervious Surface	Best Availat	Best Availat	Land Cover	30	Meters		
<input type="checkbox"/> National Land Cover Database 2001 - Canopy	Best Availat	Best Availat	Land Cover	30	Meters		
<input type="checkbox"/> National Land Cover Database 1992 - Land Cover	Best Availat	Best Availat	Land Cover	30	Meters		
<input type="checkbox"/> National Land Cover Database 2006 - Impervious Surface	Best Availat	Best Availat	Land Cover	30	Meters		
<input checked="" type="checkbox"/> National Land Cover Database 2006 - Land Cover	Best Availat	Best Availat	Land Cover	30	Meters		

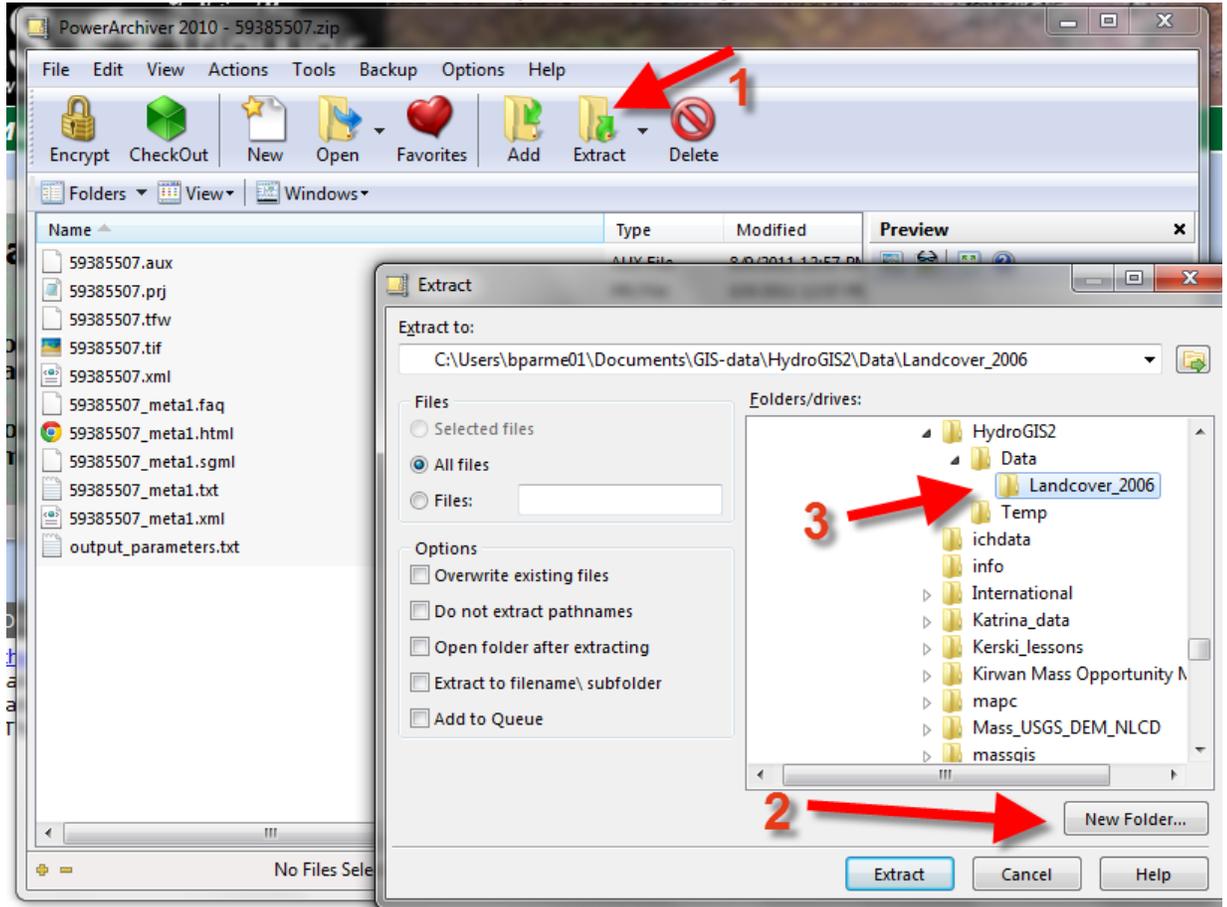
Back Get the 2006 Land Cover! Next

Elevation (4 products)							
Product	Month	Year	Type	Resolu	Units	Metadata	
<input type="checkbox"/> National Elevation Dataset (NED) 1/9 Arc Second	11	2006	Elevati	1/9	arc second		
<input checked="" type="checkbox"/> National Elevation Dataset (1 arc second)	Best Availat	Best Availat	Elevati	1	arc second		
<input type="checkbox"/> National Elevation Dataset (1/3 arc second)	Best Availat	Best Availat	Elevati	1/3	arc second		
<input type="checkbox"/> National Elevation Dataset (1/9 arc second)							

You want the 1 arc second elevation data set

17. Click on **Add to Cart**
18. Examine your "Cart" - you should have *Hydrography*, the *National Land Cover* data set for Land Cover, and the *National Elevation Dataset* in 1 arc second resolution
19. Click on **Check Out** and follow directions to **Place Order** (and write down the order number when it appears)
20. Check your e-mail for notice that data layers are available for download - some layers (with GeoTiff formats) will be ready immediately because they are raster data sets which are easy to extract. The hydrography data may take a while.

21. Create appropriately named subfolders within your *Data* folder (e.g. landcover, elevation, NHD)
22. When you get the initial e-mail back from the USGS, it will have download links to the land cover and elevation data sets. Download each data set in turn to your HydroGIS folder. Extract each data set to its appropriate sub-folder. **Be careful to extract each data set to its correct subfolder! The example below is using Power Archiver:**

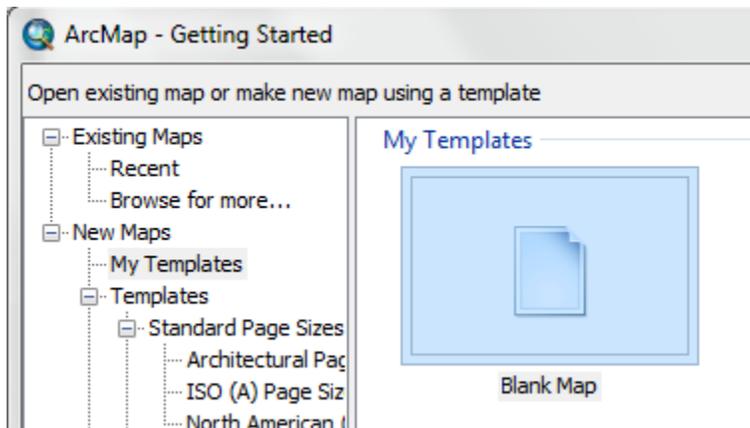


You will receive another e-mail when the hydrography data is ready. It is called NHD (for National Hydrograph Data). It will typically be ready in an hour or two but may take up to two business days.

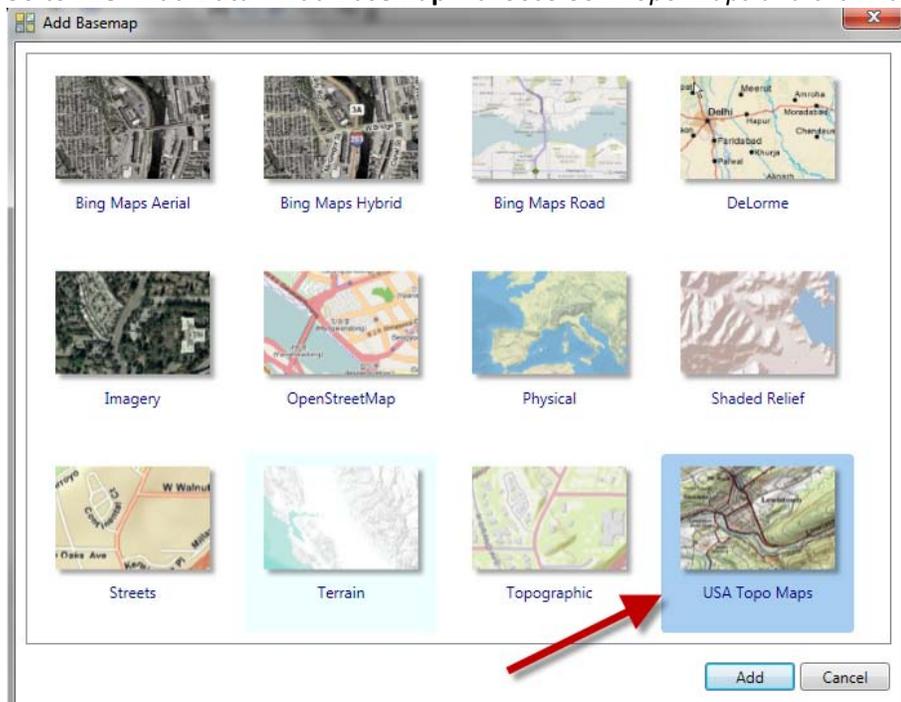
## Getting Started in ArcMap

Start ArcMap. If you are in the Tufts GIS Lab in Tisch Library, choose **Start-All Programs – GIS Applications - ArcGIS 10 – ArcMap** or click on the Desktop icon for **ArcMap**.

1. When the first dialog box comes up, highlight the option to start **New Maps – My Templates – Blank Map** and press OK

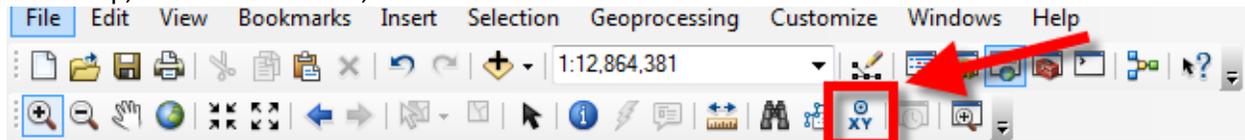


2. Choose **Customize - Toolbars**, and make sure that *Standard* and *Tools* are visible.
3. On the left side of the screen, you should see your *Table of Contents* area - right now it should only say "Layers".
4. Go to **File - Add Data – Add Basemap** – choose *USA Topo Maps* and click **Add**

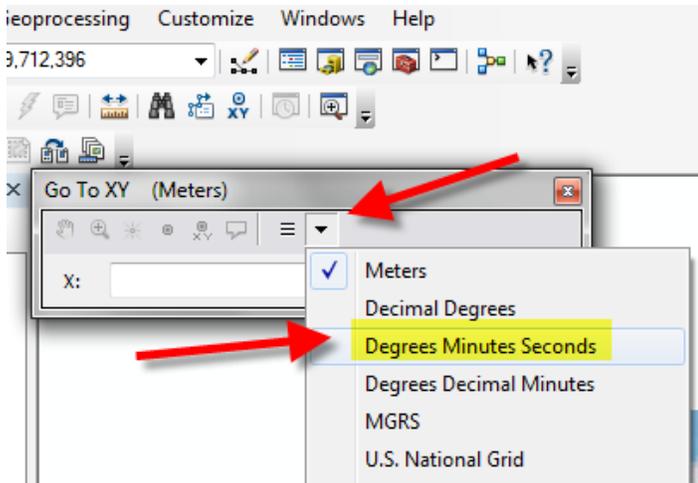


Note: Adding a Base Map works inconsistently and requires an internet connection. And it can be slow. Be patient. If it doesn't work, try again.

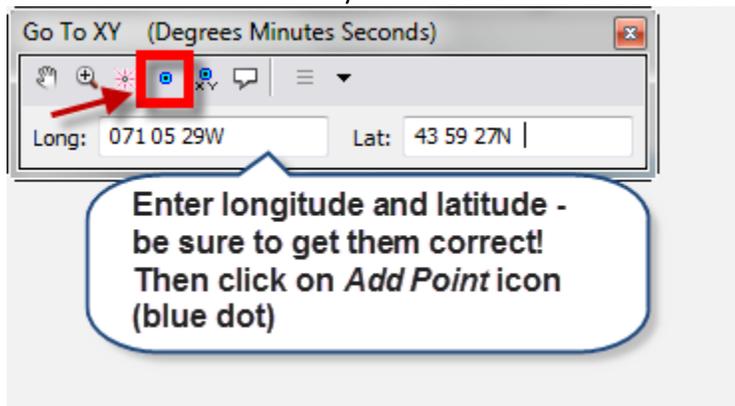
5. In ArcMap, from **Tools** toolbar, click on *Go to XY* icon



6. Click on the *units* drop-down arrow as show below to choose your units to be Degrees-Minutes-Seconds:

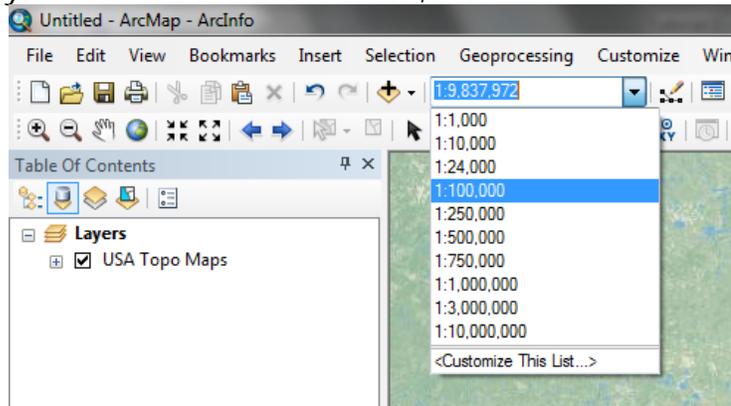


7. Type the *Stream Gage Station* coordinates from the HCDN in the form – you can paste them but make sure to edit them to substitute spaces for the colons, and also note that the **West** coordinate is **Longitude**, and the **North** coordinate is **Latitude** so that they have to be pasted in the reverse order of what you recorded from the HCDN network!

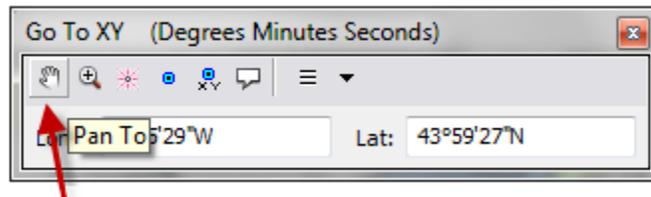


8. Click on the *Add Point* icon – this adds a graphic point at that location.
9. Still on the “Go to XY” tool, click on the *Zoom To* icon  – this will center the screen over your stream gage.

10. In the *Scale* box of the *Standard* toolbar, select the 1:100,000 scale as shown – your view will zoom to a 1:100,000 scale



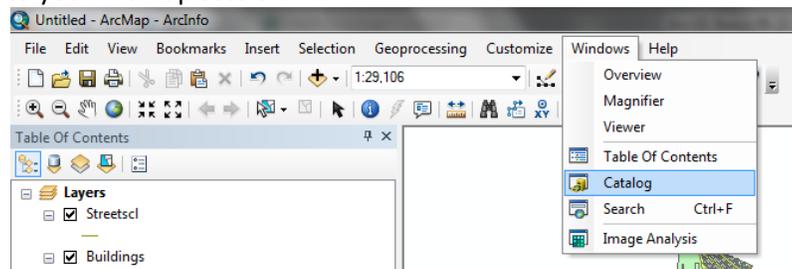
11. The USGS has a 1:100,000 scale map series and that is what you are seeing now (1 inch on the map equals 100,000 inches in the real world) – pan around the map at this scale.
12. Select the 1:24,000 scale – this is another map series from the USGS (often called quad maps or 7.5-minute quadrangles maps, and is the one most familiar to natural resource managers and hikers)
13. Re-center your map on your stream gage



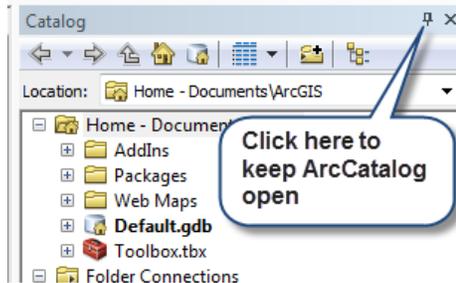
## Using ArcCatalog within ArcMap to Manage Data

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

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



2. 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)



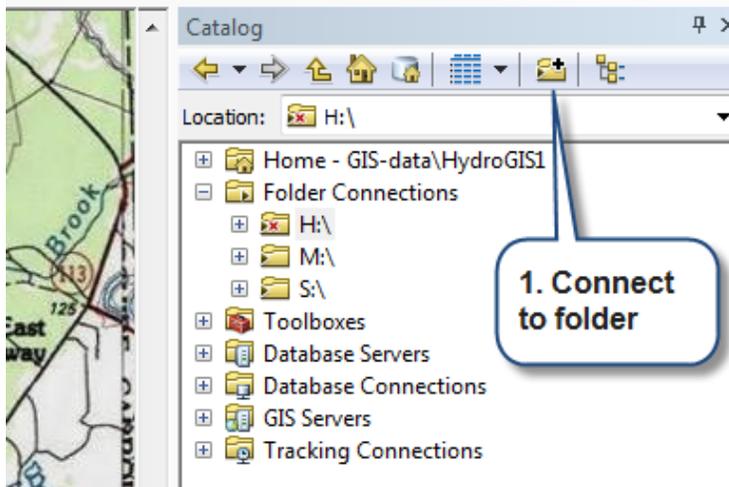
## Understanding and Using Folder Connections

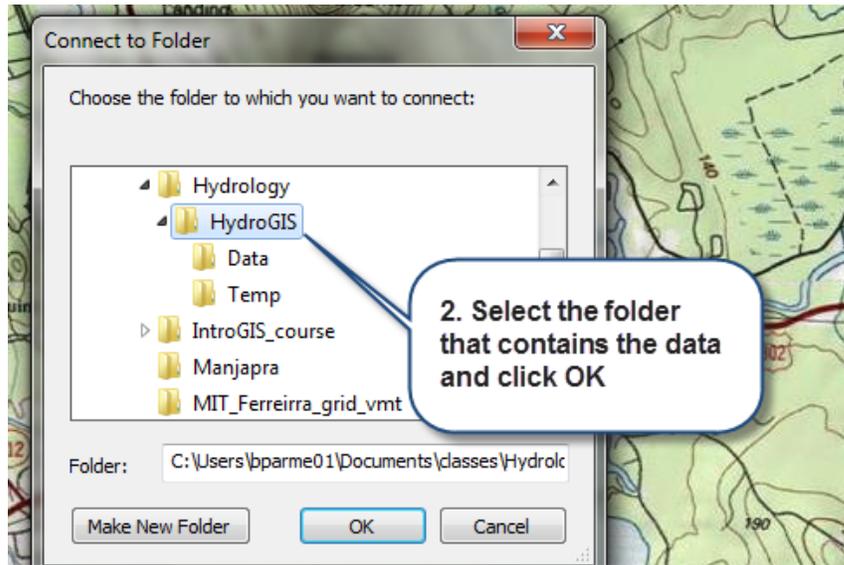
If you are in the Tufts GIS Lab, you will see that you have three **folder connections** already – to H:, S:, and M:. The H: drive is your personal storage space. The M: drive holds data sets that Tufts has acquired for your use. And the S: drive holds class specific materials. The **folder connection** is a direct connection to these spaces in ArcGIS, and allows you to quickly access your data without navigating repeatedly through long folder paths.

If you're working in the GIS lab, ignore the following directions and proceed to the next section.

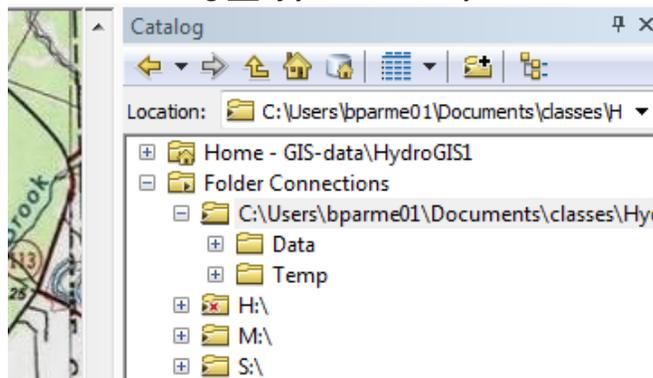
At home or other locations outside the Tufts GIS Lab, you will not have pre-set folder connections. You will need to add these yourself. The first step is to think about how best to organize your work, and create the folders necessary in your home computer using your Windows software – for example, you might create a folder path in My Documents *for Classes – Hydrology – GIS Tutorial*.

In the example below, I've made a folder on my home computer under *My Documents* called *Classes*, and a subfolder path for *Hydrology – HydroGIS* to hold my data. 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*, as you see below:

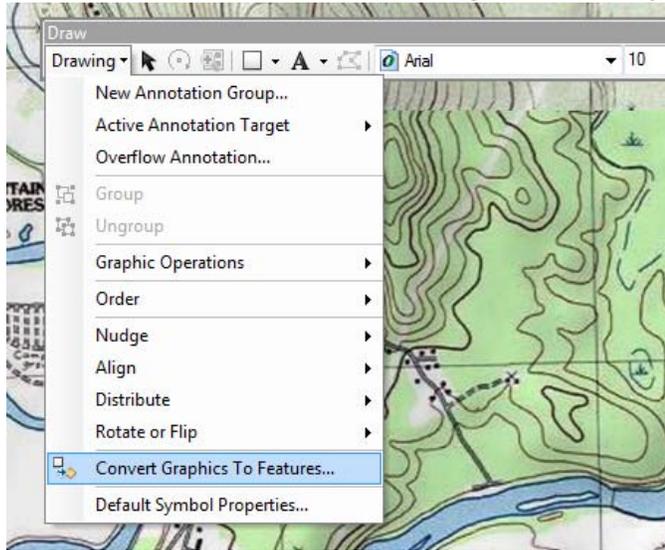


## Converting the Stream Gage Graphic to a GIS Data Set

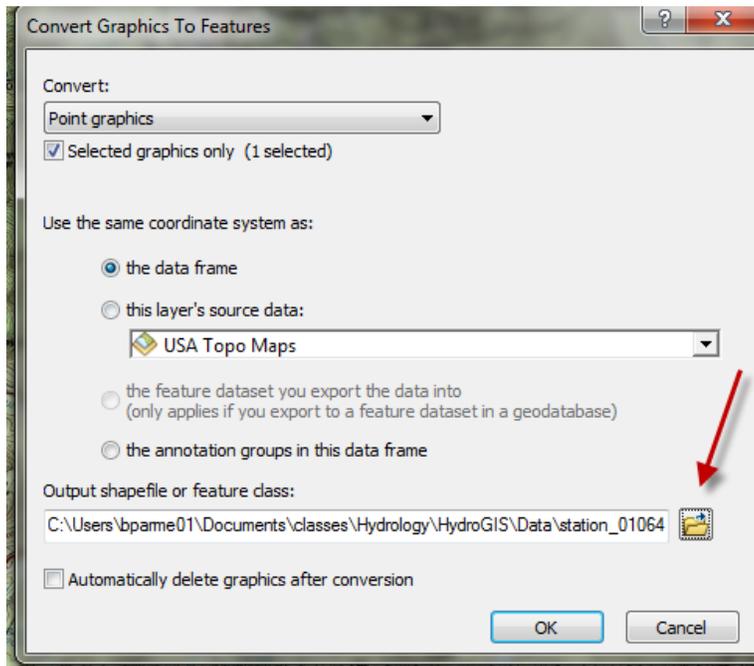
Your stream gage is going to be an important landmark for you but right now it is just a graphic on your screen. You want to convert this to its own GIS file, called a shape file, so that you have it stored permanently.

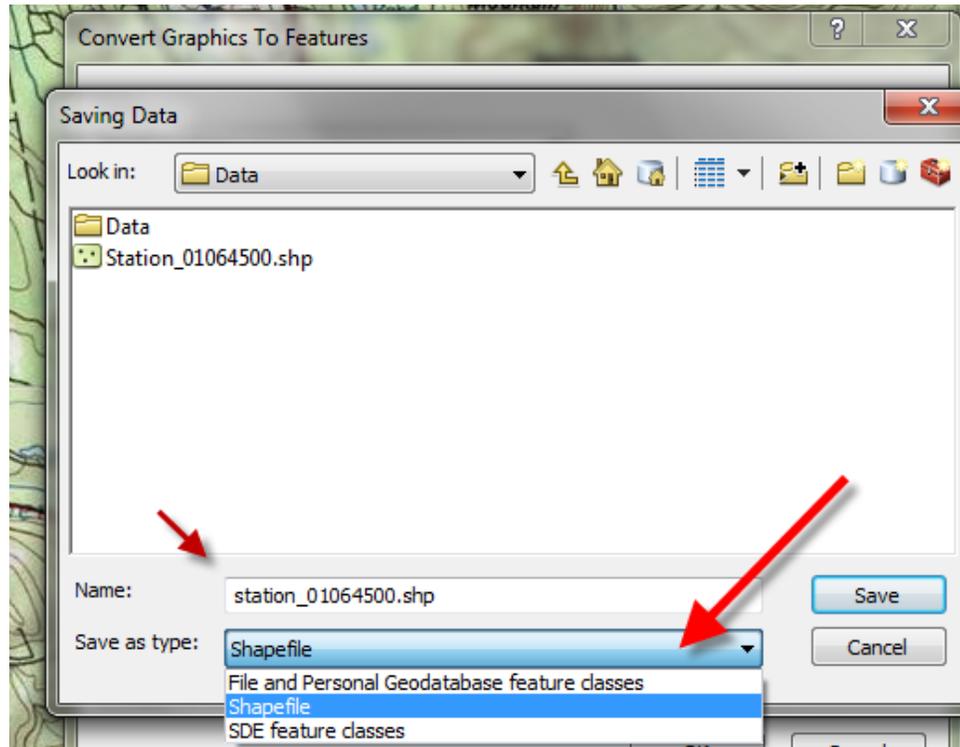
1. **Customize – Toolbars** and add the **Draw** toolbar

2. From the *Draw* toolbar, choose **Drawing - Convert Graphics to Features...**



3. Follow the graphics below - click on the folder icon and navigate to your HydroGIS project Data folder to save the file as *Station\_X.shp* (where *X* is the station number from the HCDN database, e.g., *Station\_01064500*), and make sure it is saved as type: *Shapefile*.



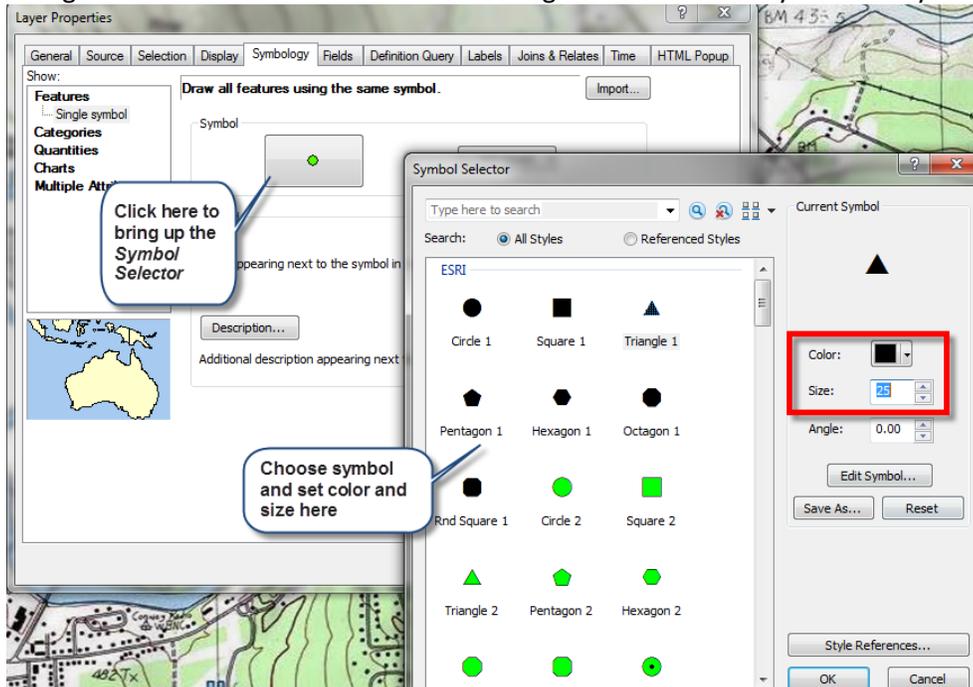


4. Click *Yes* when asked if you want to add it to the map.
5. Save the mapfile (**File - Save**) – call it **Hydro Base Map1** and place it in your *HydroGIS* folder. A map file is a very small file that contains pointers to your data sets and remembers what you had up in your session. If you quit ArcMap at this point, the next time you start it, you can choose to start with this existing mapfile and it will automatically pop up the US Topo Maps and your stream gage point. Thus, map files are easy ways to save work. But beware - map files DO NOT contain the data layers, they only have references to the data layers. If you copied your *Hydro Base Map1.mxd* file and tried to open it on a home computer without the GIS data layers it is referencing , 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.
6. You can delete the graphic now that you have saved the point as its own GIS data set. Use the *Select Elements* tool on the *Tools* toolbar to select the graphic, then press the *Delete* key:



7. Right-click on your *Station\_X* data layer in the *Table of Contents* and choose **Properties**

8. Click on the **Symbology** tab
9. Change the icon for the station into something that is more clearly visible on your map



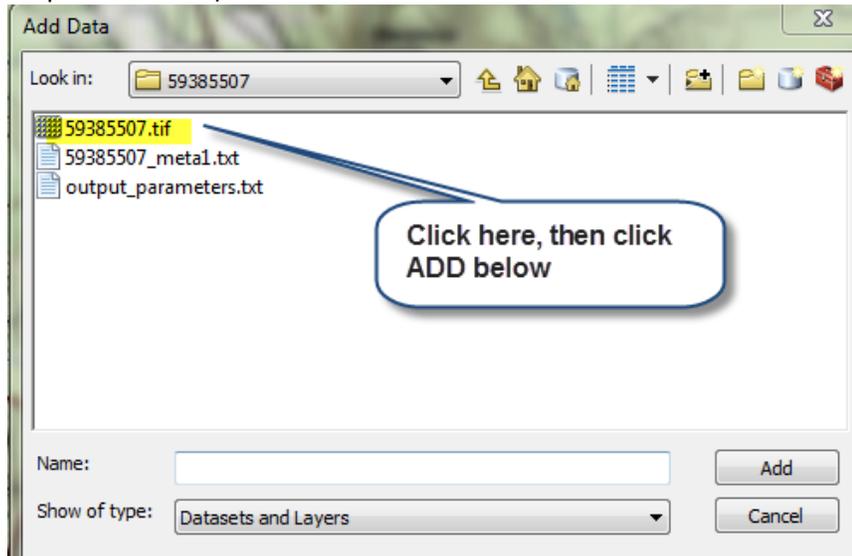
10. Explore your area by panning around. If you lose your stream gage point, right-click on your **Station\_X** data layer and choose *Zoom to Layer*.
11. When you are finished, choose **File – Save** to save you mapfile.

## Adding National Land Cover Data (NLCD) to your Map

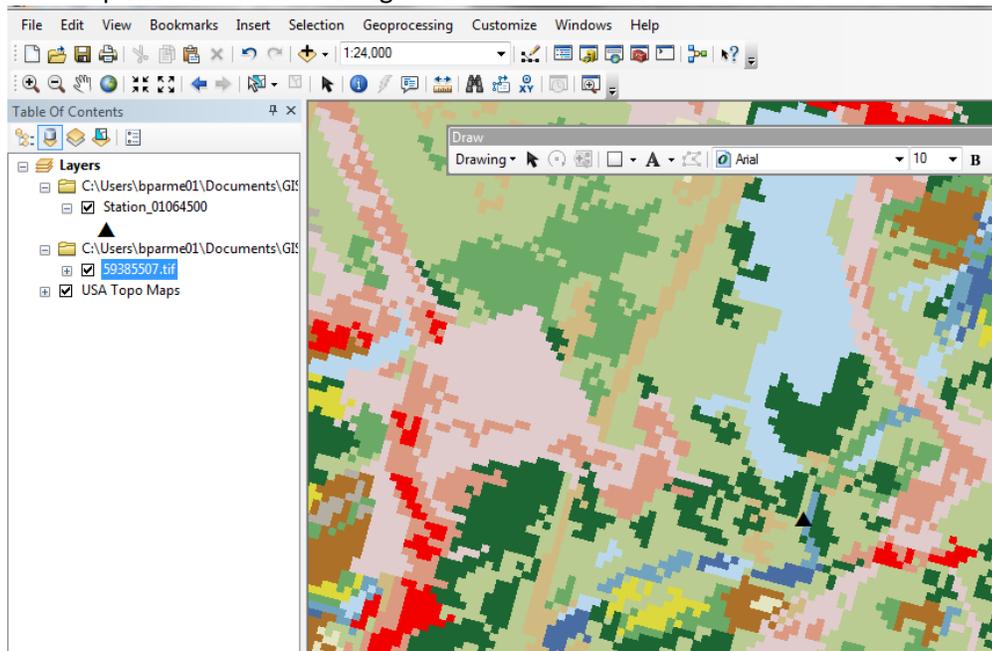
The NLDC Land Cover Data will give you a spatial representation of land cover for the region of your watershed, based on 2001 satellite imagery and ancillary data sets. Before you use the data set you downloaded from the National Map, you need to understand what it represents. You can get this information at the Multi-Resolution Land Characteristics Consortium (MRLC) web site, as follows:

1. Go to the *MRLC* web site: <http://www.mrlc.gov/>
2. Go to **Find Data** - select **National Landcover Database 2006** - then **Legend**. This explains codes and color. You'll find these codes in the attribute table of the NLCD data that you downloaded earlier.
3. In ArcMap, click on the **Add Data** icon (  ) in the Standard Toolbar.
4. Add the *Land Cover* data set that you downloaded earlier from the National Map and unzipped (you will have to navigate to the folder where you saved it and drill down a

couple subfolders).

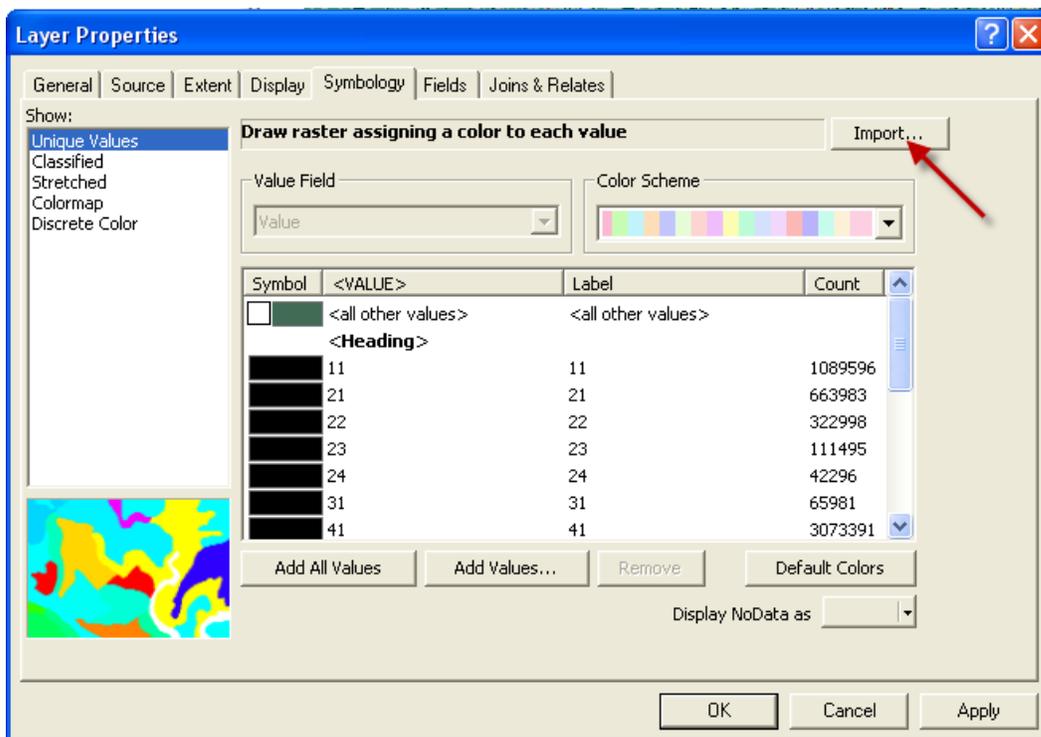


5. Click yes if asked if you want to “create pyramids” – this speeds up display.
6. For now, ignore the *Geographic Coordinate System* warning by clicking **Close** on the warning box.
7. Your map should look something like this:

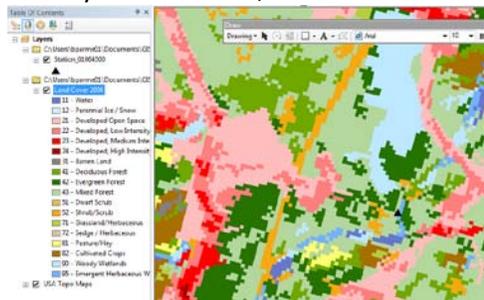


8. *Right-click* on the land cover layer in the *Table of Contents* and choose **Open Attribute Table**.
9. The *Value* column contains the land cover codes that you read about in the *MRLC 2006 Land Cover Legend* and the *Count* column gives you the number of grid cells that have a given code.
10. Close the attribute table
11. *Right-click* again on the land cover layer in the *Table of Contents* and choose **Properties**
12. In the **General** tab, rename the data set *Land Cover 2006*

13. Review the information in the **Source** tab – this is a raster data set composed of an array of grid cells. Each cell is 30x30 meters – we know this from seeing the *cell size* (30,30) and, further down, the linear unit of the spatial reference is *meters*. If you zoom in close, you will see the individual cells.
14. If you haven't already, download the [Land Cover 2006.lyr file here](#) and save it to your project folder. This contains the same NLDC landcover classification schema you downloaded in Step 3, but is formatted to import into ArcMap. Save the layer file to your *Data* folder. (if you're working from a hard copy of this tutorial the layer file can be found by going to the Tufts GIS Center web site – <http://gis.tufts.edu> – then to the *Learning GIS section-Online Tips and Tutorials-ArcGIS 10 Tutorials*.)
15. Still in the *Properties* interface, click on the **Symbology** tab.
16. Click on **Unique Values** on the left hand side. This shows you only the actual values that occur in your land cover data set.
17. Apply this layer file using the *Import* function



18. When you're finished, click on OK. Your map should look something like this:



19. Save your map file (click **File-Save**)

## Adding the National Hydrography Data set

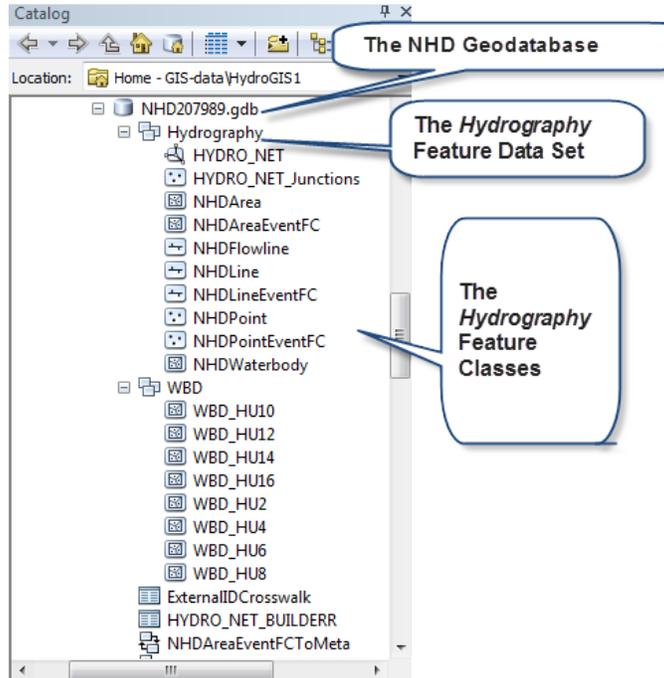
*This section is to be done after you receive an e-mail message that your NHD data set is ready to download.*

The National Hydrography Data set (NHD) is the USGS' most up to date digital version of mapped surface water features in the US. The data set is modeled in a way that allows for various types of analysis, including flow. For background about the NHD here: <http://nhd.usgs.gov/>.

A geodatabase can contain feature datasets, which are groups of

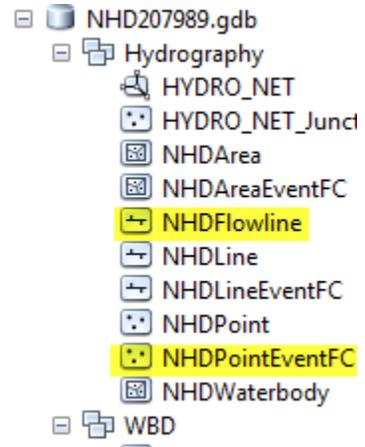
similar features. A feature data set then contains feature classes – each feature class represents one type of feature. In the NHD Geo geodatabase, there are two feature datasets: hydrography and WBD (for watershed boundaries, or in some data sets, you'll see Hydrologic Units instead of WBD). The hydrography feature data set has several feature classes – here are some of them:

- NHDFlowline – The core linear network of the surface-water drainage system primarily consisting of streams, and artificial paths through lakes and other water bodies to model the flow of water.
- NHDWaterbody – Polygons representing waterbody features such as lakes.
- NHDArea – polygons primarily representing the area of hydrographic features. E.g., if a river is wide enough, on a topographic map it shows up as a filled-in blue area (polygon in GIS-speak) and not just a line. These are represented in the NHD data set by the NHDArea feature class.
- NHDPointEventFC – Point Features addressed to the network. Includes stream gages and dams. The stream gage points include an attribute column with links to flow data from the USGS.
- HYDRO\_NET\_Junctions – Nodes between NHDFlowlines used by the geometric network for flow navigation. You don't need to load this in your map, but ArcMap will use it for flow analysis later in this tutorial.

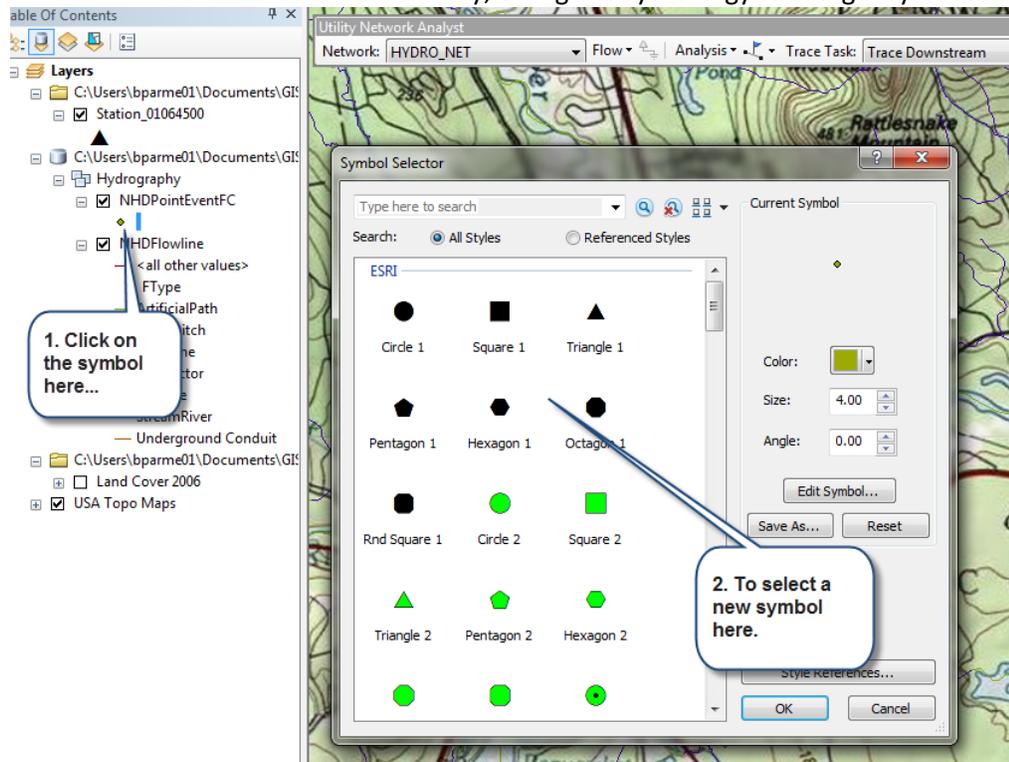


In this section, you will only need to add the **NHDFlowline** and the **NHDPointEventFC** feature classes, but if you have some extra time, you are encouraged to explore some of the other feature classes as well.

1. Check your email for a message from *NHDAutoEmailer* that the *NHD* data set is ready for download
2. Follow the link and download the *NHD* file to your data folder
3. Uncompress the data set
4. In ArcMap, use the *Add Data* icon (  ) to open the geodatabase
5. Navigate to where you unzipped the *NHD* data set and drill down to find the geodatabase
6. Double-click on **Hydrography**
7. Select **NHDFlowline** and **NHDPointEventFC** and click **Add**
8. Again, ignore the *Geographic Coordinate System* warning by clicking **Close** on the warning box.
9. Because map files can sometimes get corrupted, save your map to a *new name* (**File – Save As**) – call it **Hydro Base Map2 with NHD**
10. Explore the two new layers – what do they represent?

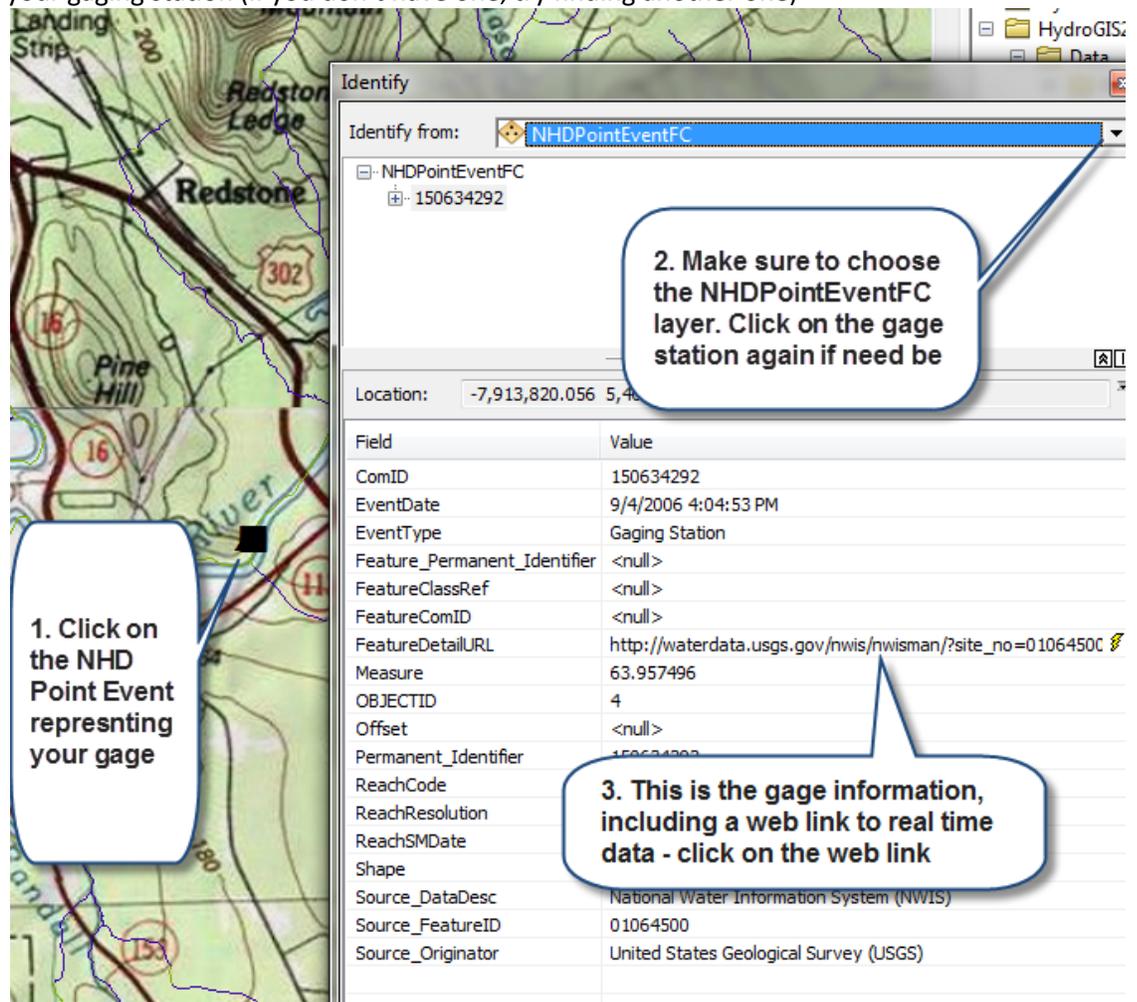


11. To see the *NHDPointEvents* more clearly, change its symbology to a larger symbol:



12. There should be an *NHDPointEvent* that represents your stream gage – it may be on top of or nearby your gage station point. Locate it.

- Click on the **Identify** icon  and then click on the *NHDPPointEvent* that represents your gaging station (if you don't have one, try finding another one)



1. Click on the NHD Point Event representing your gage

2. Make sure to choose the NHDPPointEventFC layer. Click on the gage station again if need be

3. This is the gage information, including a web link to real time data - click on the web link

Field	Value
ComID	150634292
EventDate	9/4/2006 4:04:53 PM
EventType	Gaging Station
Feature_Permanent_Identifier	<null>
FeatureClassRef	<null>
FeatureComID	<null>
FeatureDetailURL	<a href="http://waterdata.usgs.gov/nwis/nwisman/?site_no=01064500">http://waterdata.usgs.gov/nwis/nwisman/?site_no=01064500</a>
Measure	63.957496
OBJECTID	4
Offset	<null>
Permanent_Identifier	150634292
ReachCode	
ReachResolution	
ReachSMDate	
Shape	
Source_DataDesc	National Water Information System (NWIS)
Source_FeatureID	01064500
Source_Originator	United States Geological Survey (USGS)

- Click on the **FeatureDetailURL** – this will open a web site with real time data web site from the USGS for this gaging station.
- Close the **Identify** window
- Uncheck** the *NHDPPointEventFC* data layer in the *ArcMap Table of Contents*.

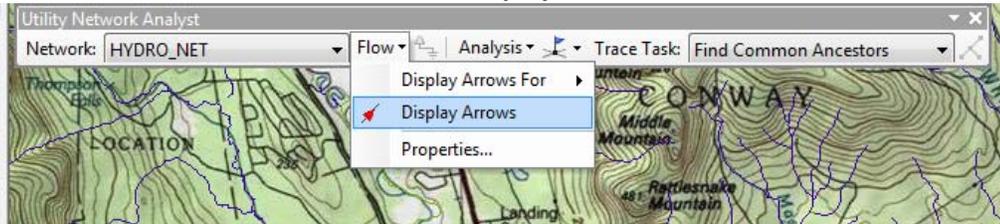
You've learned how to acquire data sets, how to add them to ArcMap, and a bit about the structure of the National Hydrography Data set. In the next section we'll work with the NHD more.

## Tracing upstream networks using NHD

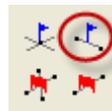
The NHD database structure contains embedded information about the direction and linkages of the flow network. ArcGIS has a tool, *Utility Network Analyst*, which can utilize this embedded information to trace upstream and downstream.

- Make sure your *NHD Flowlines* are turned on in the *Table of Contents*

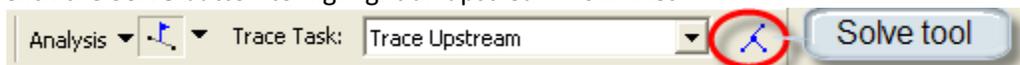
2. Click on **Customize – Toolbars** and check mark *Utility Network Analyst*.
3. To see the flow direction, turn on **Flow-Display Arrows**



4. After examining the flow directions, turn off the *Display Arrows*
5. *Zoom into* the stream gage you located earlier (right-click on it in the *Table of Contents* and choose **Zoom to Layer**)
6. In the *Utility Network Analyst* toolbar, click on the down arrow next to the **Add Junction Flag** tool to expand the options

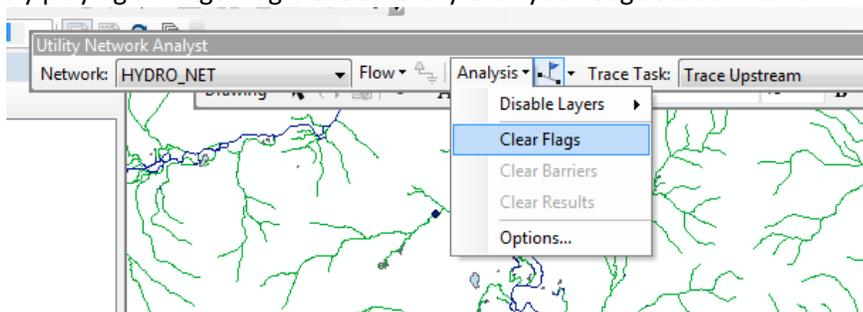


7. Choose the **Add Edge Flag Tool**
8. Click the *NHDFlowline* near the stream gage to set the analysis point – turn off the land cover and US Topo Maps if you need to see the stream gage more clearly
9. From the *Trace Task* options, choose **Trace Upstream**
10. Click the **Solve** button to highlight all upstream flow lines



11. Zoom out to see the streams tributary to the gage you have selected

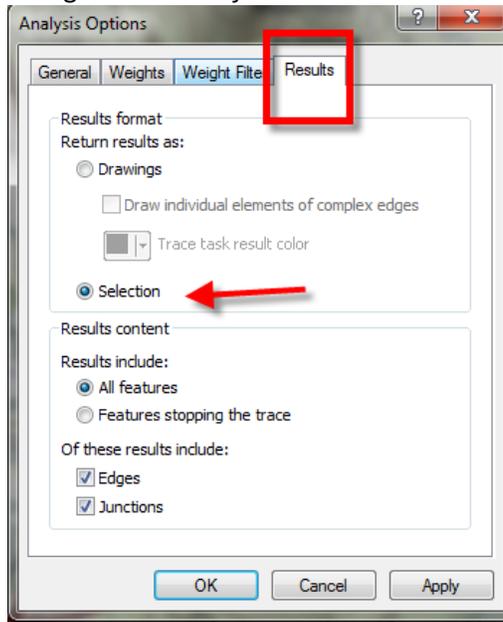
Note: if you don't see any streams highlighted, you may have not placed the Edge Flag exactly right. Click on *Analysis – Clear Flags* to clear your original flag, then zoom in and try playing an Edge Flag more carefully over your Gage Station Point:



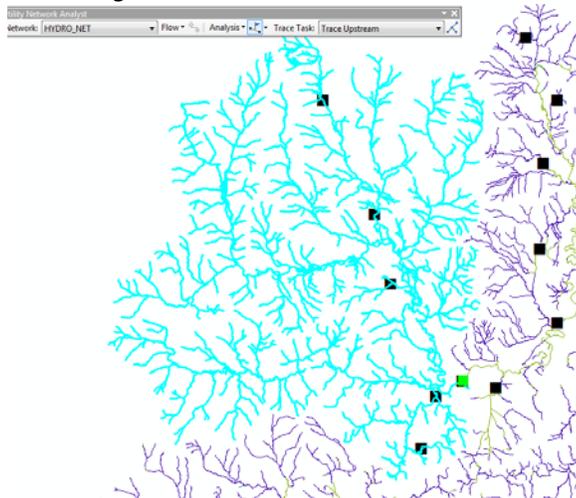
- Now choose **Trace Downstream** from the *Trace Task* options, click on *Solve*, and observe the highlighted flow path

While these highlighted results are great for viewing, if we want to share these results with others or bring them up easily later, we want to save the result as a shape file.

- Under **Analysis** choose *Options*
- Change the *Results format* to **Selection** and click *OK*



- Change the *Trace Task* back to *Trace Upstream* and click *Solve*. You should see something like this:



- You're going to create a new GIS data set out of these selected features
- In the *Table of Contents*, **right-click on the *NHDFlowline* layer**, then choose *Data / Export Data* and save as "*Station\_xxxxxxx\_tributaries.shp*" to your *Data* folder. Note that it is set to saving the selected features. Leave the coordinate system default set to

Same as this *Layer's Source Data*. Click Yes when prompted to add the exported data as a layer to your map.

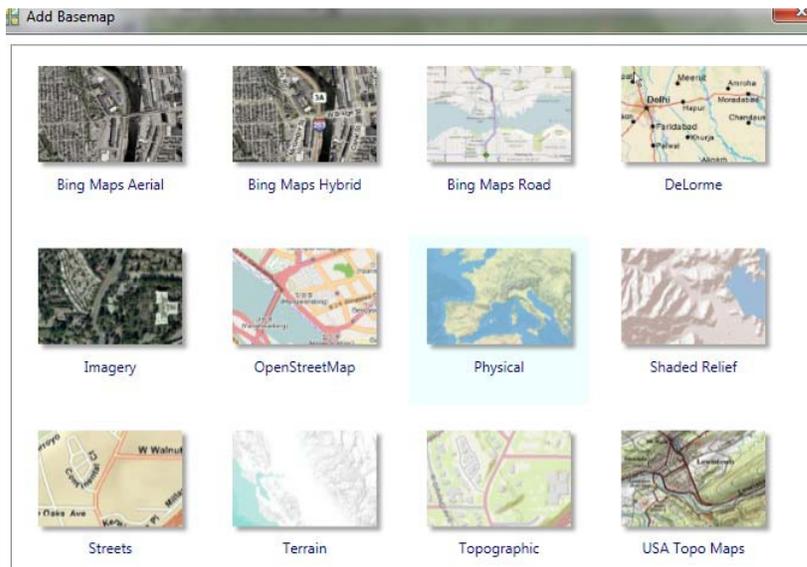
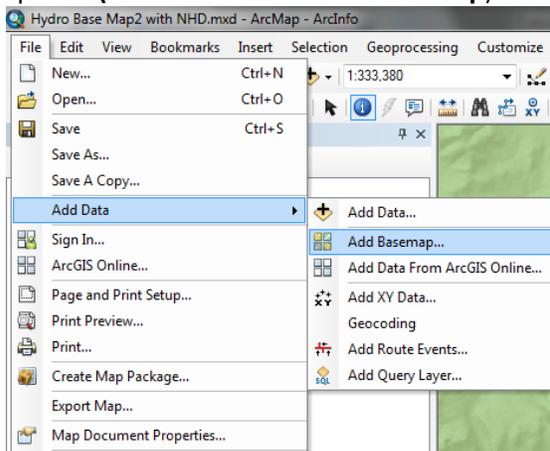
17. On the *Tools* toolbar, use the *Clear Selected Features* button



18. Right-click on the *Station\_xxxx\_tributaries* layer and select *Properties*
19. On the *Symbology* tab, change the color to a bright blue and click OK
20. Clear the network flag graphic by clicking on *Analysis* in the *Utility Network Toolbar* and choosing *Clear Flag*
21. **Turn off** the *NHD Flowlines*
22. Save the mapfile (**File - Save**)

## Adding other data layers for context

Your maps need some visual context. Depending on your purpose and your display scale you may want to use the *US Topo Maps* or another data layer available from ESRI "base map" options (**File – Add Data – Add Basemap**):



Turn these on and off, zoom in and out, and explore which views provide good information about your watershed and how that might vary by which basemap you choose.

Note that you can make the *Land Cover* data set slightly transparent so that you can see *Shaded Relief* or another base map layer beneath it. To do this, right **click on the Land Cover 2006** data layer, and choose **Properties**, and then the **Display** tab. Set the *transparency* to something like 50.

Save the mapfile when you're done (**File - Save**)!

### Creating a map for printing

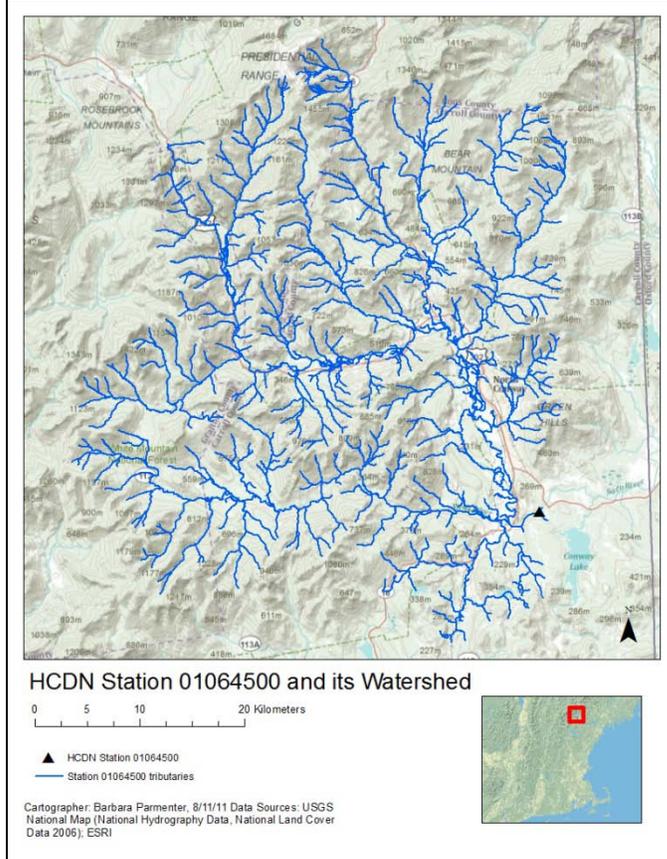
You create a layout when you are ready to design a map for printing or inclusion in another document. A *layout* is a view of your data, much like viewing the page layout when you are working in a word processing software. You should use the *layout view* when you are ready to design a map, having done all the preliminary work and analysis in the *data frame view* (where you have been up to now in this tutorial).

Produce two maps, a base map and a land cover map, on 8.5" by 11" paper. Each map should include:

- the map itself (which is what you see in your *data frame*)
- a title
- a legend
- a scale
- a north arrow
- the name of the cartographer (you)
- a date
- citations for your map's data sources

On the base map, show topography, streams tributary to your stream gage, and populated places near your watershed. Here is an example of a base map in layout

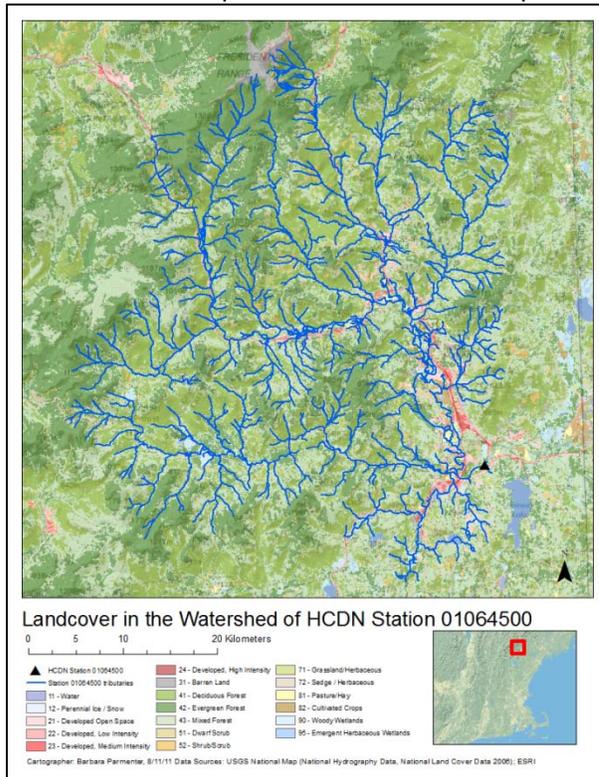
view:



Note that you can also have more than one data frame on a layout - for example, you can have a an inset map to show an area in *more* detail or to show the larger context (e.g., a map of New England to that shows where the watershed being mapped is located). See the later section *Adding a data frame to show two or more maps on a layout* for instructions about how to do this.

The other map should be a land cover map, showing the land cover raster and streams tributary to your stream gage.

Here is an example of a land cover map in layout view:



## Setting up a layout

1. In ArcMap, choose **View - Layout View**. Note that there is a new *Layout* toolbar.
2. The first thing you should do is to set up your *Page Properties*. Choose **File – Page and Print Setup**
3. In the *Page Setup* dialog box, make sure that the paper size is set to *Letter*. Also check either *Portrait* or *Landscape* (thinking of the shape of your watershed, which would be better for the map you want to create?) Press *OK* to return to the map.
4. Make sure you give proper, readable names to the data layers that will be on your map. Do this by renaming them in the Table of Contents, e.g.:

Original	Renamed
<input type="checkbox"/> <input checked="" type="checkbox"/> Station_01064500 	<input type="checkbox"/> <input checked="" type="checkbox"/> HCDN Station 01064500 
<input type="checkbox"/> <input checked="" type="checkbox"/> station_01064500_tributaries 	<input type="checkbox"/> <input checked="" type="checkbox"/> Station 01064500 tributaries 

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

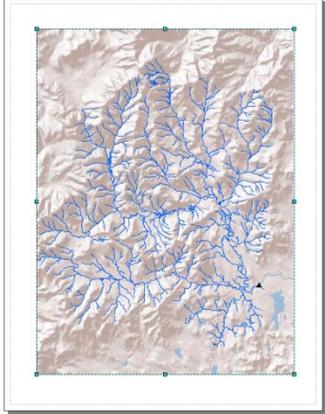
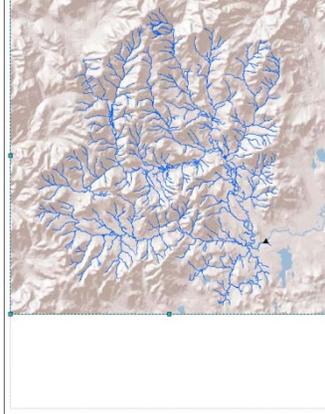
### Moving around in the layout versus the data frame

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 downtown). 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><b>The Tools Toolbar</b></p> 	<p><b>The Layout Toolbar</b></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><b>Data frame and layout page not adjusted</b></p>	<p><b>Data frame after resizing and moving to fit the layout page</b></p>
	

Moving and re-sizing in ArcMap works similar 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.

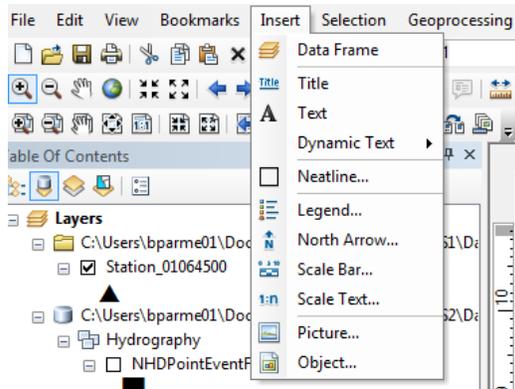
### Inserting a title, north arrow, and legend

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:

#### Inserting a title, north arrow, and legend

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



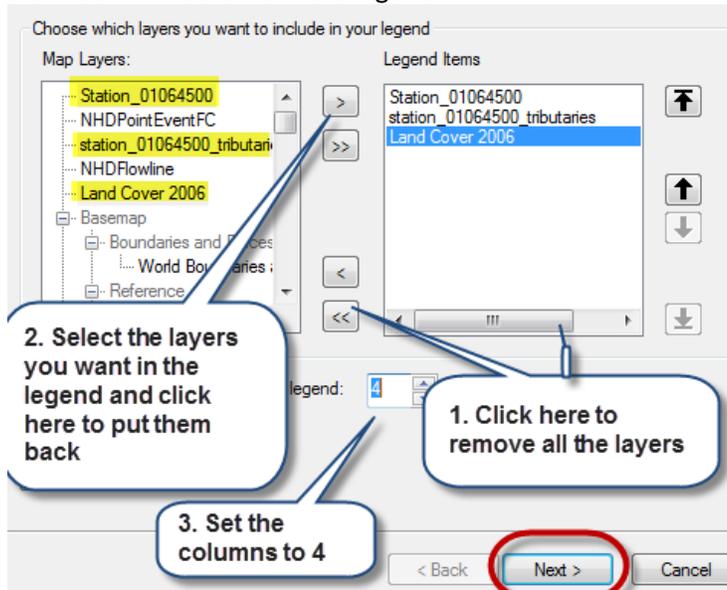
#### Insert Scale Bar

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

1. There are lots of ways to improve your legend. For starters, let's say we're creating a land cover map. We want the legend and map to focus on land cover. We might have shaded relief in the background as in the example map, but it doesn't have to on the legend. To control what goes on the legend:  
Choose **Insert - Legend** from the main menu

2. Adjust what is in the legend so that only your Stream Gage station, its tributaries, and the 2006 Land Cover is in the legend:



3. Accept the defaults for the rest of the Insert Legend Process until it is finished.
4. Modify the size of the legend by using the corners to shrink it or expand it, and move it to a good location

You can modify a 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. Under the ITEMS tab, you can also change the number of 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

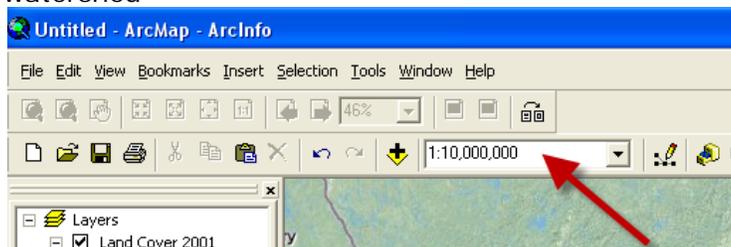
To put in your name as the cartographer, and any other information, use the **Insert -Text function**. Remember also to include a date. You should list your data sources. You can change font properties on selected text by right-clicking on the selected text and choosing Properties

**Save your mapfile!**

## Optional: Adding a data frame to show a regional locator map

You can add a second data frame 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 view*, all the data frames will appear. This can be handy for putting in a small "locator" map we saw earlier.

1. To add a second data frame, we recommend that you go back to the *Data* view (choose **View - Data View**).
2. Choose **Insert - Data Frame**. Your map disappears because a new empty data frame has taken its place. The new data frame can be found by scrolling to the bottom of the table of contents.
3. On the top of the *Table of Contents*, click on the **List by Drawing Order** tab
4. Left click on *USA Topo Maps* in your original data frame **drag it down** to the *new data frame*. Turn it on. It will take a while to draw, be patient! Ignore any warnings.
5. In this new data frame, zoom in to the general region of your watershed. Tip: you can drag down your HCDN Station if you need it to locate your region.
6. Now set the *Map Scale* to 1:10,000,000 (just type 10000000 in the scale area) – this will give you a good larger view of the region around your watershed

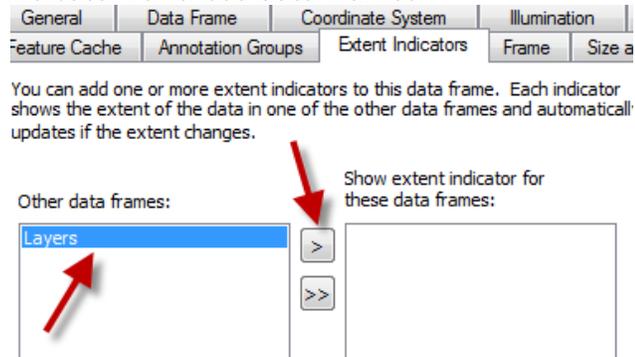


7. Now go to *Layout* view (**View - Layout View**) and you will see both data frames in the layout.
8. You can select one data frame for moving or resizing by using the Select pointer icon (  ). Play around with moving and resizing data frames. To switch data frames, you must select it with the pointer icon. This is what can get confusing, but when you finally get the hang of it, it can be a very powerful tool.
9. In *Layout* view, you can *activate* one of the data frames by double-clicking on it.

Now you will set up a boundary box as in the map examples shown earlier. To do this:

1. Right-click on **New Data Frame** and go to *Properties*

2. Click on the **Extent Indicators** tab
3. Under the *Other data frame* column, highlight *Layers* and then click on the right-pointing arrow to put it in the right-hand column under *Show extent indicator for these data frames*



4. Click OK
5. Feel free to change the scales of either of your data frames to suit your maps. Just make sure to click on the map first in *Layout* view to **activate** it, then type in a new scale or use the zoom in/ zoom out buttons from the *Tools* toolbar.

## Saving maps under different names

Once you have created the base map in a layout you like, save a new map file (**File – Save As**) and call it *Saco River Base Map* substitutin your river for Saco). You can then use the same layout turn on the land cover data layer and save the map file as *Saco River Land Cover*).

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.

## Printing or exporting layouts

You can print directly from ArcMap or you can export to a digital graphic format like .pdf. Printing works just like any other Windows program.

For printing from ArcMap, simply use the **File – Print** command. In the GIS lab, the default setting is Black and White for the GIS laser printer, so to print in color adjust the printer commands after you choose the *GIS laser printer* (click on the **Properties button**, then the **Color** tab, then **uncheck** *Print in Grayscale*)

For exporting to a digital format, choose **File – Export Map**. In the dialog box that follows, click on **Save as Type** to see the various typs of digital files you can create. You can also set resolution in the dialog box.