Week 11 Cookbook: GIS Tutorial Chapter 8
Spatial Data Processing and Analysis

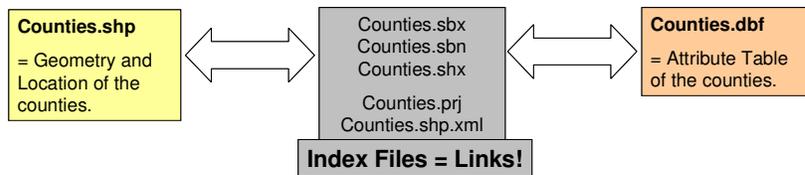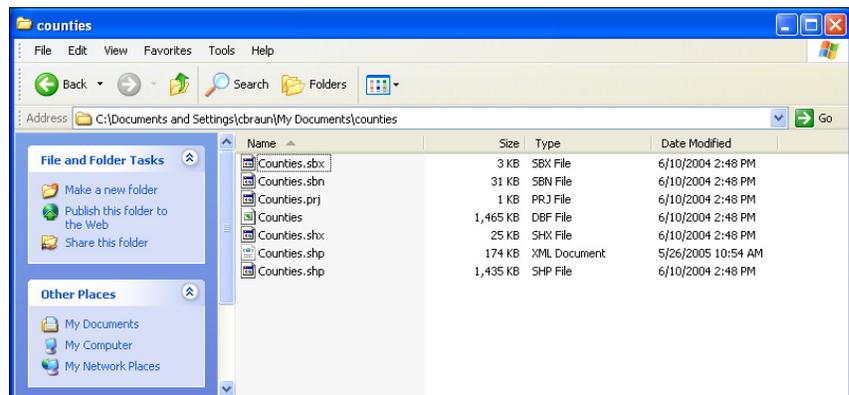## Week 11 Overview

11.1) What is Spatial Data Processing and Analysis?
11.2) Select By Attributes
11.3) Select By Location
11.4) Your Turn: Chapter 8 (Page 272 to 289 only!)
11.5) The Buffer Tool

It all comes back to the basics: Geospatial data is spatial data and attribute data linked together.

This allows us to perform data processing and analysis using the location of a feature and its characteristics.

For example, we can select an important wetland using some biodiversity indicator, then create a 1 mile buffer around the wetland for protection, and determine which building parcels are located inside this buffer. Then we can talk to the homeowners about reducing pesticide runoff from their lawns into the wetland.

Counties.shp
= Geometry and Location of the counties.

Counties.sbx
Counties.sbn
Counties.shx

Counties.prj
Counties.shp.xml

Index Files = Links!

Counties.dbf
= Attribute Table of the counties.

This basic sequence described above is referred to as geoprocessing, GIS analysis, GIS modeling, etc. Whatever the name, the basic idea is the same: Use the power of geospatial data for meaningful analysis.

Consider printing this cookbook for your convenience

11.1) What is Spatial Data Processing and Analysis?

Spatial data processing and analysis go together: you process your data as part of an analysis, but you also often need to process your data before you can start your analysis!

Consider the following example:

You work for the City of Westfield Planning Department as a GIS Specialist and are tasked to delineate a new business/industrial park to stimulate the local economy based on the following three criteria:

1. The parcel has to be at least 10 acres in area.
2. The parcel has to be at least 100 ft from any wetland or water body.
3. The parcel has to be already industrial or commercial zoned to avoid a contentious rezoning process.

This is a classic GIS analysis task which you need to break-down into a series of steps:

Step 1   Project Organization
                    This is often overlooked…before you start anything you need to organize the project in your head! What do I need to do? How do I get the data? What is the outcome?

Step 2   Data Acquisition
                    What data do I need? Do I have the data? Can I get the data from MassGIS? Do I have to digitize and create the data myself?

Step 3   Data Exploration = test-drive your data to make sure that you really have the data you need to perform your analysis.

Step 4   Data Manipulation, for example editing, sub-selecting the needed features using Select By Attributes, Select By Location, clipping, merging, combining, etc. Data often cannot be used 'as-is', but need some manipulation.

Step 5   Data Analysis = translating the three written criteria above into a sequence of ArcGIS Tools. This is best done by creating a flow chart to visualize the analysis steps.

Step 6   Map Creation (= making your analysis meaningful for other people).
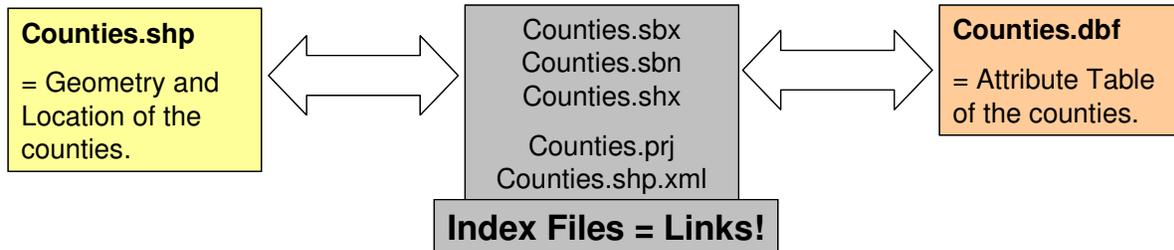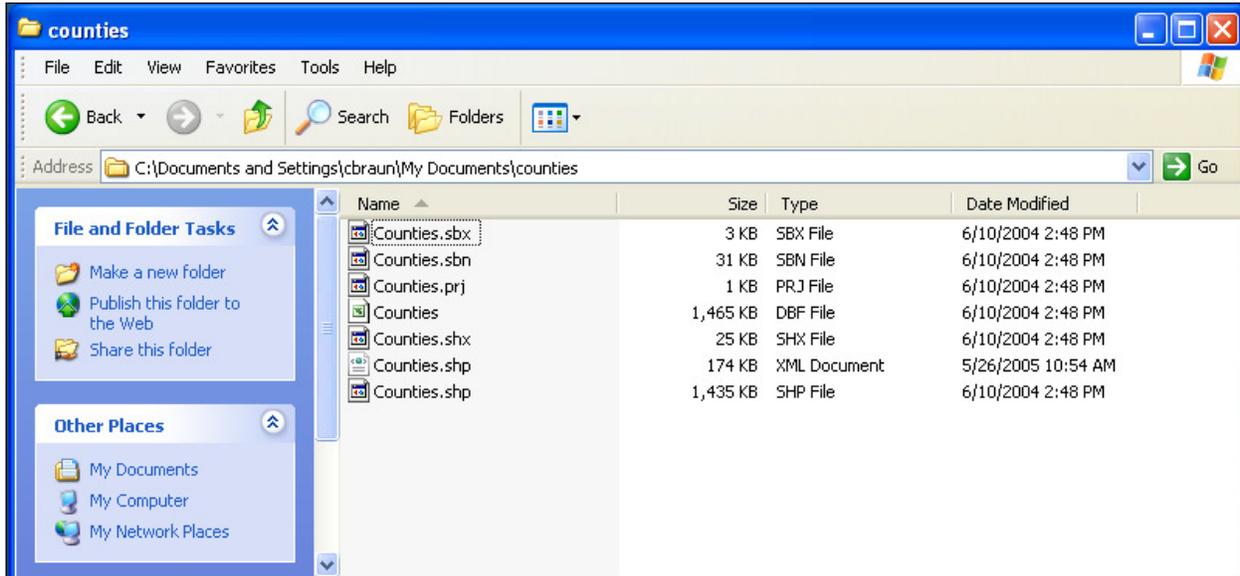
Sounds easy, but here are a few common mistakes:

• People tend to forget about Step 1.
• People tend to jump to Step 2 and then immediately to Step 5…this usually does not work, since you first need to manipulate the data.
• People tend to forget creating a flow chart before starting the data analysis.
• People tend to be too focused initially with the end product…the final map. Nothing wrong with planning ahead, but Step 6 is impossible without Steps 1 to 5.
• People forget to adequately document their project.

11.2) Select By Attributes

Remember: A GIS uses geospatial data that contains spatial information (= where a feature is located) and attribute information (= what a feature is).

This may sound trivial, but allows us to perform meaningful quantitative analysis.

Counties.shp

= Geometry and Location of the counties.

Counties.sbx
Counties.sbn
Counties.shx

Counties.prj
Counties.shp.xml

Index Files = Links!

Counties.dbf

= Attribute Table of the counties.

The spatial information (= the location and geometry) is <u>linked</u> to the attribute information via a series of <u>index files</u>. Therefore, we can select features based on their attributes or their location (see Section 11.3).

11.2.1) Example: Select Counties based on their Attributes

1) Create a folder on your USB flashdrive called \week11 (inside the garp0244 folder).

2) Start ArcCatalog and create a folder connection to the GIS Tutorial data folder.

3) Start ArcMap and add the Counties.shp shapefile.

Now you have a map showing all 3109 counties. The Select by Attribute tool allows you to sub-select counties based on their attributes.

4) Go to Selection – Select By Attributes to open the Select By Attributes dialog box.

The 'Select By Attributes' dialog box is very similar to the 'Definition Query' dialog box we already used. Use ONLY the bottoms provided to create your selection expression, do NOT attempt to type the expression with the keyboard.

Try to sub-select counties based on the following criteria:

1) All counties in PA.
2) All counties in PA and in Ohio.
3) All counties with more than 1,000,000 people in 2000.
4) All counties with more than 1,000 farms in 1997 (NO_FARMS97).
5) All counties with 100,000 or more black people in 2000.
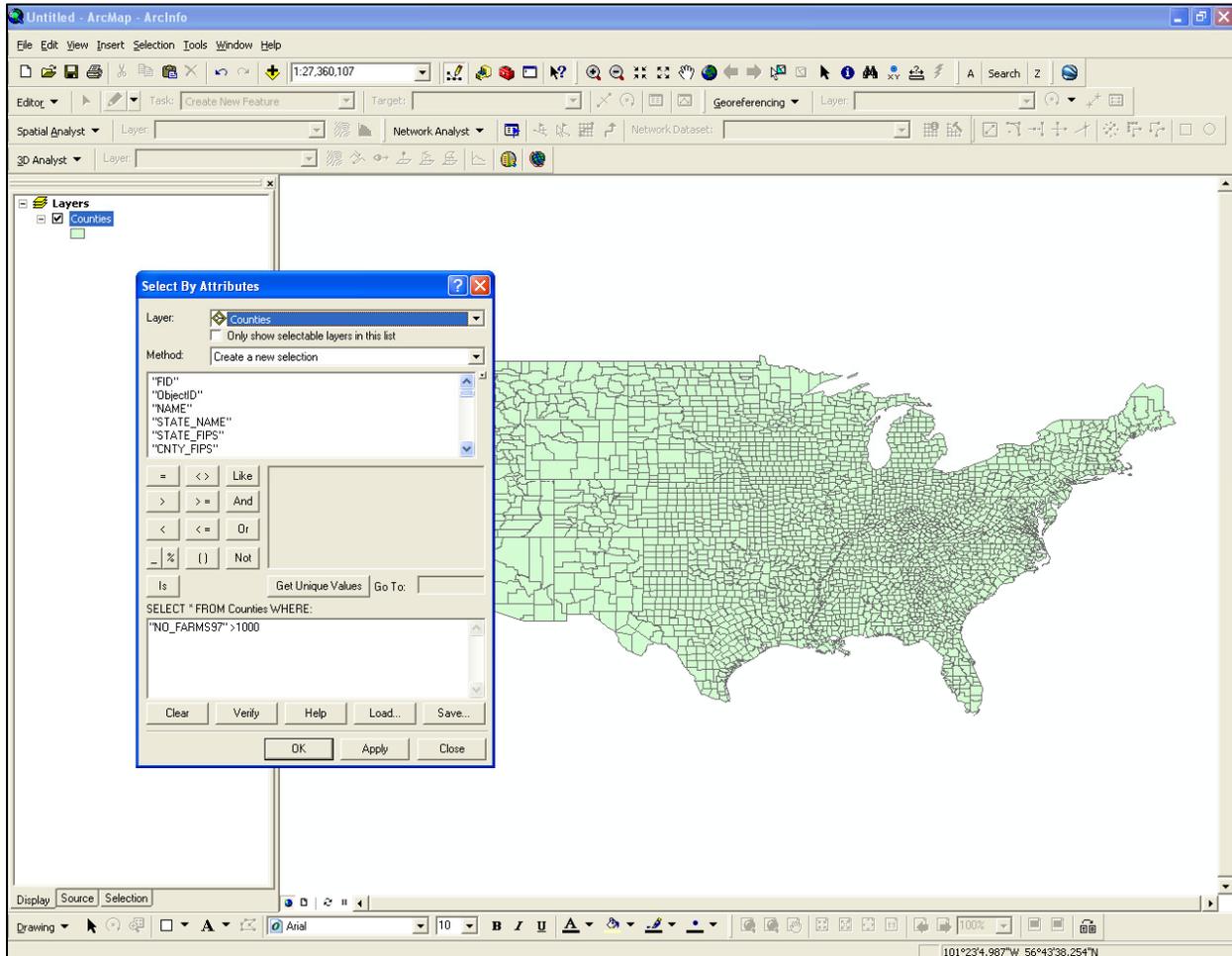
11.2.2) Example: Create a new Shapefile from your Selection

1) Use the Select By Attributes to select the counties in MA and CT.

2) Double-check your selection by checking the attribute table.

3) Right-click on the data layer, select Data, select Export Data.

4) Export the selected features into a new shapefile. Save the shapefile to your USB flash drive into the \garp0244\week11 folder, using a meaningful name.

5) Add the new shapefile to your map as a new data layer.

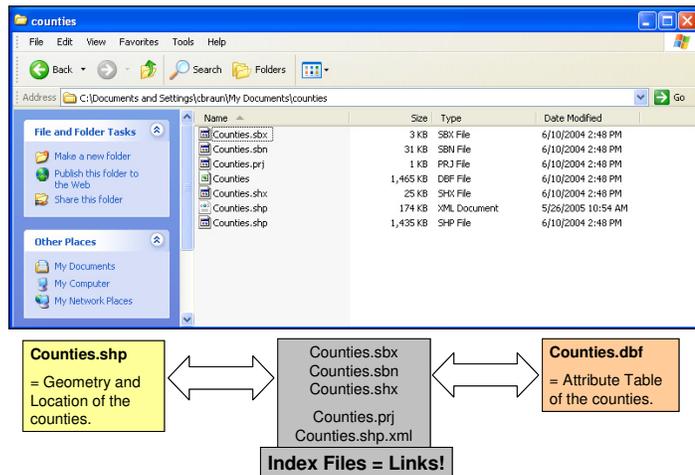> *This is a very common procedure in GIS analysis.*
> You sub-select features of interest based on their attributes and then save the selection as a new shapefile. Then, you open the new shapefile in ArcMap for further analysis and close the original shapefile. Look for the Jings in the Week 11 folder that illustrate this process!

11.3) Select By Location

Remember: A GIS uses geospatial data that contains spatial information (= where a feature is located) and attribute information (= what a feature is).

This may sound trivial, but allows us to perform meaningful quantitative analysis.

The spatial information (= the location and geometry) is <u>linked</u> to the attribute information via a series of <u>index files</u>. Therefore, we can select features based on their attributes (see Section 11.2) or their location.

Counties.shp		Counties.sbx Counties.sbn Counties.shx Counties.prj Counties.shp.xml		Counties.dbf
= Geometry and Location of the counties.	⟷	**Index Files = Links!**	⟷	= Attribute Table of the counties.

11.3.1) Example: Select By Location

1. Download (if needed) the town data layer from MassGIS. http://www.mass.gov/mgis/towns.htm Open the TOWNS_POLYM data layer

2. Download the NHESP Certified Vernal Pools data layer from MassGIS. http://www.mass.gov/mgis/cvp.htm Open the certified vernal pools layer.

3. Use 'Select By Attributes' to select Westfield.

4. Now explore the 'Select By Location' Tool and select:
   All vernal pools located in Westfield.
   All vernal pools located within 10 miles of Westfield.
   All vernal pools located in Westfield, Southampton, Easthampton, and Northampton.
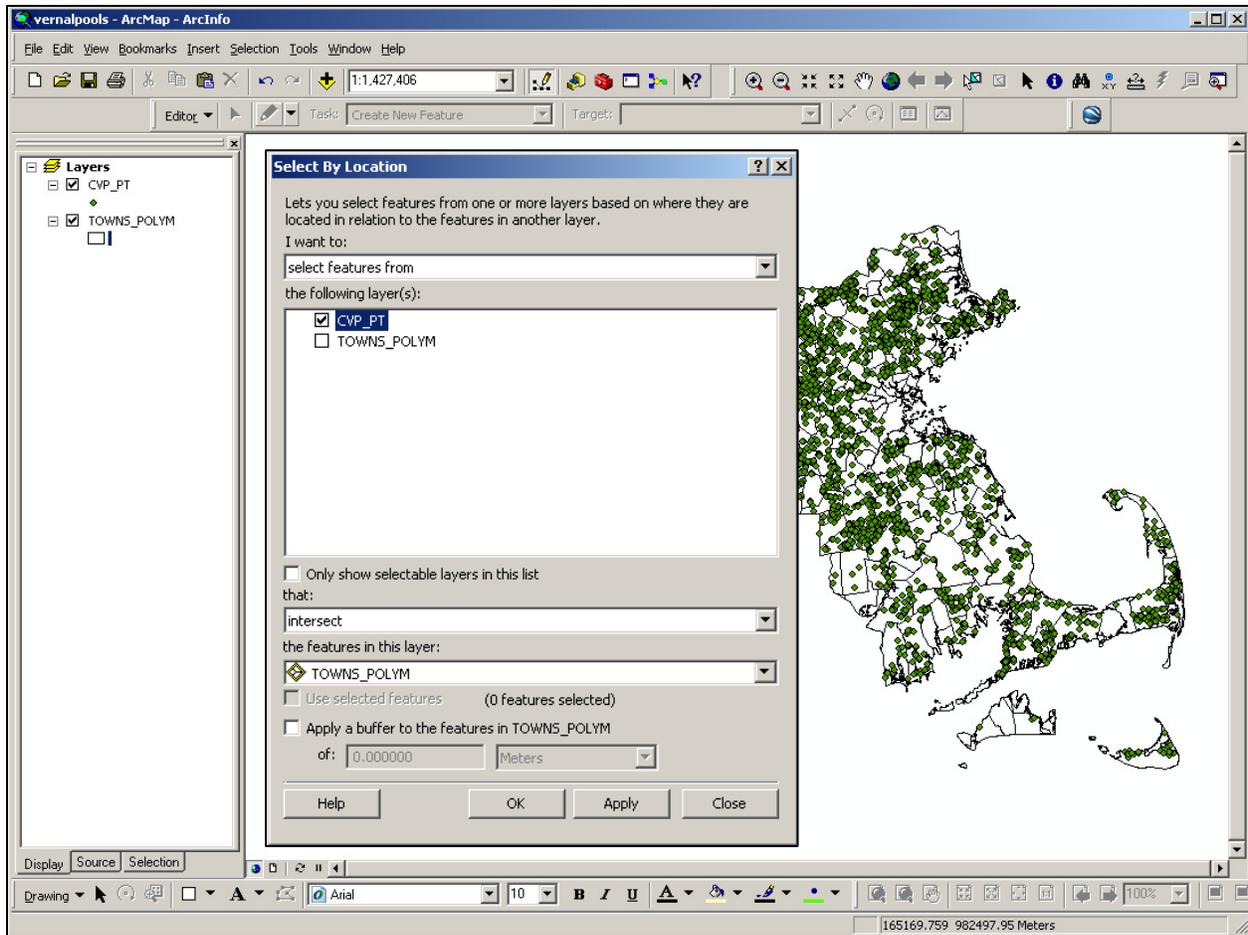
11.3.2) Example: Create a new Shapefile from your Selection

1) Use the Select By Location to select the certified vernal pools in Westfield and Southampton.

2) Double-check your selection by checking the attribute table.

3) Right-click on the data layer, select Data, select Export Data.

4) Export the selected features into a new shapefile. Save the shapefile to your USB flash drive into the \garp0244\week11 folder, using a meaningful name.

5) Add the new shapefile to your map as a new data layer.

This is a very common procedure in GIS analysis.
You sub-select features of interest based on their attributes and then save the selection as a new shapefile.
Then, you open the new shapefile in ArcMap for further analysis and close the original shapefile.
Look for the Jings in the Week 11 folder that illustrate this process!

11.4) Your Turn: Chapter 8 (Page 272 to 289 only!)

Chapter 8 is a whirlwind tour through the ArcToolbox and you will practice a series of important tools. As always, the examples are generic (here: boroughs in NYC), but these tools are very useful and important for spatial data processing and GIS analysis.

- Select By Attributes
- Select By Location
- Clip Tool. This tool is very handy, for example to clip water features (e.g. streams) where they cross a county or town line.
- Dissolve Tool. This is basically a form of generalization, for example you may want to dissolve towns to counties.
- Append Tool. Here you are merging or combining several smaller shapefiles into one larger shapefile. For example, you could append all towns in Hampden County into one file for Hampden County.
- Union Tool. This tool is similar to the Append Tool.

As always, save your files and maps not to the PC that you are working on, but instead to the \week11 folder on your USB flash drive.

A few tips and suggestions:

1) Be sure to complete each of the Your Turn boxes to practice the tools!
2) Make sure that you complete Step 9 on Page 289 (= save your final map) – you need to include this map as part of the Week 11 assignment!

11.5) The Buffer Tool

The Buffer Tool is great and has a lot of applications in GIS analysis. You have already used the Buffer Tool indirectly in Select By Location when you selected the certified vernal pools located within 10 miles of Westfield (Section 11.3.1).

You can buffer any type of spatial feature:

Point   Example: location of schools in a town
               Buffer: Distance from schools where registered sex offenders are not allowed to live.

Lines   Example: stream and rivers (= linear water bodies)
               Buffer: The 100 foot non-disturb zone around water bodies

Polygons   Example: The U.S. border
               Buffer: the 12 mile territorial waters extending into the oceans

The best way to learn the Buffer Tool is to practice, so try the following three examples.

11.5.1) Bars and Crimes

Chapter 9 of the GIS Tutorial (Page 304 to 307) contains a short, but complete application of the Buffer Tool. First, you will create 0.25 mile buffers around a series of bars. The, using Select By Location, you will select assaults that occurred within this buffer zone and create a new shapefile for those assaults.

> Be sure to complete these four short pages and save your map (Step 9 on Page 307) – this map is part of the Week 11 Assignment.

11.5.2) Towns and Fire Stations

1) Use the fire stations map you created in Week 9 (Section 9.4.2 of the Week 9 cookbook).

2) Click on the ArcToolbox icon (red tool box) to open the ArcToolbox window.

3) Expand Analysis Tools – Proximity and double-click on the Buffer tool.
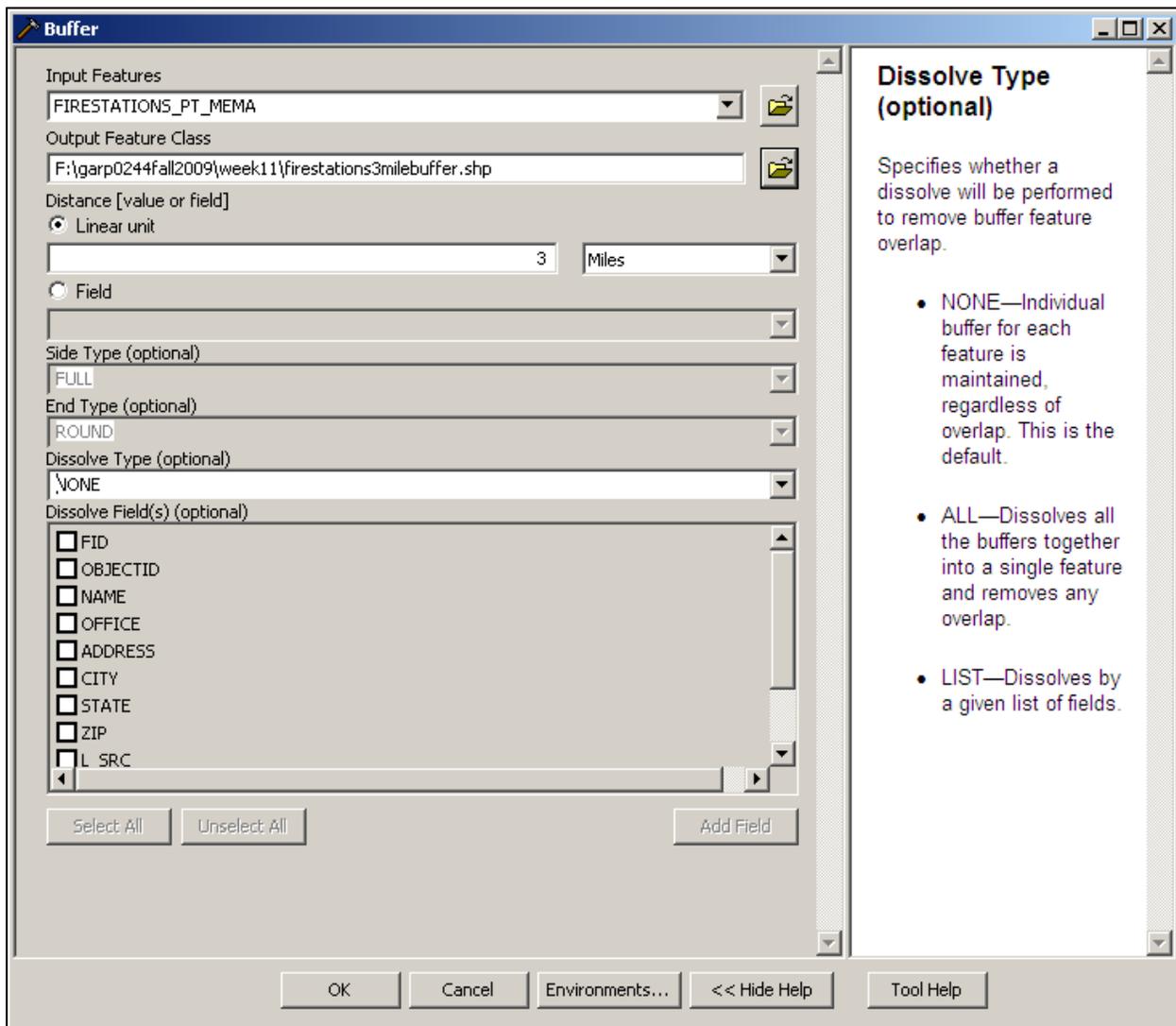
Input Features
These are the features that you want to buffer, in this case the fire stations.

Output Feature Class
Save the buffered features to your \week11 folder on your flash drive, using a meaningful name.

Linear Unit
Here you specify the size and unit of the buffer (3 miles).

Dissolve Type
Here you have a choice between NONE and ALL. NONE creates an individual 3 mile buffer around each fire station. ALL takes these individual buffers and combines them into one large buffer. The combination often makes sense, so you will use Dissolve Type = ALL in most cases. However, it also takes considerable longer to run, so for this example we will use Dissolve Type = NONE.

Please note: The right side of the Buffer Tool dialog box (white background) is context-sensitive and shows tips and explanations for each field.

4) Enter the buffer parameters as specified above and hit OK. The Buffer Tool executes and a new data layer is added to your map. This takes about 15 seconds on my old labtop and should be much faster in the Bates 022 GIS lab.

5) Create a professional map, save your map, and export your map as a JPG image. You will need this map for the Week 11 Assignment

11.5.3) Interstates in MA

Task: Create a map showing the cities and towns in Massachusetts that are located within 5 miles of the Mass Pike (I90).

1) Go to http://www.mass.gov/mgis/ftpeotroads.htm and download the Major Routes.

2) Try figuring out what to do here…Hint: It requires a sequence of Select By Attribute, Buffer Tool, and Select By Location. But…there is also an easier way to do it!

3) Create a professional map, save your map, and export your map as a JPG image. You will need this map for the Week 11 Assignment.

As I noted above, there is more than one way to perform this simple GIS analysis. Share your questions and tricks with each other in the GIS Lounge.

Week	Date	Topics, Themes, and Tasks		Assignment
Week 1	9/2 – 9/8	Welcome to GARP 0244-Online	Getting Started with Online Learning and GIS	HW #1
Week 2	9/9 – 9/15	What is GIS? Part I	Hardware, software, concepts, data, analysis, and people = GIS	HW #2
Week 3	9/16 – 9/22	What is GIS? Part II	Simple GIS: Web Mapping Applications	HW #3
Week 4	9/23 – 9/29	GIS Tutorial Ch. 1	Introduction to ArcGIS 9.3.1: ArcMap and ArcCatalog	HW #4
Week 5	9/30 – 10/6	GIS Tutorial Ch. 2	GIS Map Design: Classification and Choropleth Maps	HW #5
Week 6	10/7 – 10/13	GIS Tutorial Ch. 3	GIS Outputs = Maps: Creating Meaningful Maps	HW #6
Week 7	10/14 – 10/20	Project 1	'Lying with Maps'	Project 1
Week 8	10/21 – 10/27	Review and Reflection	Basic GIS: Intelligent and Meaningful Maps	
Week 9	10/28 – 11/03	What is MassGIS?	Online Sources of GIS Data: MassGIS and More	HW #7
Week 10	11/04 – 11/10	GIS Tutorial Ch. 6	Spatial Analysis Part I: Creating GIS Data	HW #8
Week 11	11/11 – 11/17	GIS Tutorial Ch. 8	Spatial Analysis Part II: The ArcGIS Toolbox	HW #9
Week 12	11/18 – 11/24	Project 2	MassGIS Project	Project 2
Week 13	11/25 – 12/01	Project 2	MassGIS Project	Project 2
Week 14	12/02 – 12/08	Project 2	Mass GIS Project	Project 2
Week 15	12/09 – 12/15	Project 3	Zoning for Westfield and Holyoke	Project 3