ENVR/GEOG 260 – Introduction to Geographic Information Systems
<u>LAB 5 – Cartographic Modeling, Site Location, and Spatial Analysis</u>

<u>Due date</u>: Thursday, December 5, 2002

<u>**NOTE**</u>: This lab is fairly extensive, but there are many instances where I ask you to address specific items or questions in your lab write-up. **<u>These will be denoted by bold face and underlined text</u>**. Be sure that you address these items in your write-up, as this is where much of your grade will come from!

As in previous labs, you will be using the <u>Getting to Know ArcGIS Desktop</u> as a primary reference book for many of the functions in this exercise.

<u>Introduction</u>

The purpose of this lab is to acquaint you with the ideas of project management, and demonstrate how complex spatial analysis functions are performed using vector GIS systems. In this exercise, you will be asked to identify choices for the location of a new landfill in Henrico County, based on criteria that will be defined for you in the lab, and using data from a variety of sources. The end result will be a map of possible sites, as well as your recommendation for the best landfill location. You will show how the project is conceptualized, how the data are to be organized, and what analyses will be performed.

<u>Data</u>

The data are in “zipped” format, which means you need to “unzip” the data to your network drive prior to starting the lab. I suggest you create a folder specifically for this Lab 5 assignment, and place the data files into that folder. (Proper organization in advance of starting any project will make things go much more smoothly later in the project!) The data are included in a file called “lab5data.zip”.

The data and files included in the compressed file are as follows:

- Henrico County outline map
- Unified outline map of counties surrounding Henrico County
- Virginia roads, interstates, schools, churches, and hospitals (in separate layers)
- Land-use/land-cover classification of Henrico County, along with a file describing the classification scheme
- A PDF file of this lab (what you are looking at now)

<u>Lab Background</u>

In this lab, you will play the role of a planner who has been tasked to provide Henrico County administrators with a list of possible locations within Henrico County to locate a new landfill. To help you make this determination, you have been given a set of criteria that possible site locations must meet:

- The sites must be located within 2 miles of a major road (defined as an interstate or U.S. highway), so that the area is accessible to heavy truck traffic
- The sites must be at least 1.5 miles from any river, even if it is not in Henrico County (to help prevent waste from contaminating the local water bodies)
- The sites must be located at least one mile from any school or medical facility (to comply with local health regulations)
- The sites must be at least ½ mile from any church (because we're nice folks…)
- The sites must be at least 300 acres in size
- The sites must be located a minimum of 500 meters of any Land Cover area designated as either "water" (land cover code 10) or "wetlands" (land cover code 90)
- The sites must be located at least ½ mile from any interstate highway (we'd like to keep the landfill from being visible from the interstate)
- The site must be completely within Henrico County (our trash is our problem, not our neighbor's)

You can see from these criteria that our potential landfill must comply with many different (and sometimes seemingly contradictory) demands. A GIS is a useful tool in helping to reconcile the potential conflicting requirements.

To facilitate your analysis, you have been provided with the following data:

- Highway and road data
- Locations of schools, churches and hospitals
- An outline map of Henrico County, as well as an outline map of all the counties that surround Henrico County
- Data concerning water bodies in and around Henrico County
- USGS Land Use-Land Cover (LULC) data

<u>Your tasks in this lab are three-fold:</u>

1. You will design a cartographic model to detail the type of analyses you will undertake to solve the problem, along with the inputs and outputs of the model (a flow chart works well for this)
2. You will perform the analysis of the problem, showing the results at each step
3. You will use the results of this analysis to designate likely candidates for landfill sites, which you will present in both map and tabular form

<u>LAB PROCEDURES</u>

<u>1. Project Design – Cartographic Modeling</u>

The first part of the project is perhaps the most important: designing your model such that you understand of the objectives of the project vis-à-vis the capabilities of your system, knowing how the data and analysis techniques fit into the project, and understanding the flow of operation through your system. To this end, you will create a ***cartographic model***, a detailed set of procedures and operations to be performed to yield a final map of the project results. One of the best ways to describe a cartographic model is to use a <u>flowchart</u>.

<u>**Using the procedure illustrated in class, create a detailed flowchart of your project, showing the operations to be performed, the data being used, and the order of**</u>

operations for your analysis. Your flowchart/model should be of sufficient detail that and reasonably competent person with knowledge of the goals of the project can understand what you are doing and how you are doing it. It should clearly show what sorts of GIS operations are being performed on which data sets, what the outputs of the operations are, the order of operations, and how the intermediate results contribute to the final results. **When this flowchart/model is complete, translate the contents of the flowchart into a text-base discussion of the model, explaining how each piece fits together to contribute to the final product.**

Please note: This first part of a project is probably the most important part of *any* project, since it is far cheaper and easier to correct potential problems early in a project's lifespan than to try to fix problems later. For that reason, pay particular attention to how you assemble your cartographic model!

2. GIS Analysis

In this part of the lab, you will take the project steps you delineated in the earlier part of the lab and actually perform the operations to yield new GIS products, which will then be used in subsequent operations.

Naturally, the first part of any exercise of this scope is to determine the geographic qualities of your data (projection, coordinate system, etc.), and to convert the data into a common system that is compatible with your problem. One of the important questions to be addressed in later analyses pertains to the area of selected parcels, and the questions are all phrased using the "English" system of measurements (feet, miles, acres, etc.). For this reason, converting your data into a coordinate system that is compatible with these questions is important, and placing the converted data into a geodatabase is necessary (as this adds attributes related to area of polygons to your data). The ideal coordinate system to use for this lab is the VA State Plane system, 1983 datum, using "feet" as the units. **Convert all the data files into this common coordinate system, using the tools in ArcToolbox. Then, create a personal database in ArcCatalog to hold the data, and import the converted shapefiles into this geodatabase using ArcToolbox.** Open a new data frame and load the contents of the geodatabase you created into the frame. You will be using these data from this point onward. (Note: failure to work entirely within the geodatabase you create will necessitate having to continually re-add the final analysis results to a separate geodatabase at the conclusion of the lab, prior to evaluating the resulting candidate areas for size.)

Next, use the procedures you developed in Part 1 of this lab to create the layers you need to perform each stage of the analysis. In general, these steps will be combinations of buffering and unioning the data, creating new polygon layers as a result. **Identify each layer being buffered and combined, being sure to adhere to your model. Show the results as screenshots, being sure to label what layers when in to producing the intermediate results, and how the intermediate results fit into the final product. You will perform this part of the lab as often as is necessary to accomplish the modeling tasks.** Notice that as you perform the operations, the results are constantly being added to the geodatabase, and the polygon measurements are being updated to reflect the results of the operations. (This is important to your final results!) As you approach the end of the analysis stage, your results polygon layer will have become quite complex, containing many shapes. This is to be expected, so don't be alarmed.

A note concerning the LULC layer: the LULC system is set up to describe land cover using a two-digit identifier. In this lab, the identifier has been truncated such that all codes are multiples of 10. This information is located in a field called "LU_code". When buffering the land use layer, use a query to find the polygons corresponding to either "10" (water) or "90" (wetlands).

Once your analyses are completed, you will need to select those polygons that meet the final size criteria. You will note that your polygon area units are in feet, but the size required of final landfill sites is listed in acres. You will need to perform a unit conversion to correctly query the data about the final possible sites. **Add a new field to your attribute table to hold the converted measurements (as per the previous lab, being careful to use "floating point" numbers with the proper precision and scale), and create a calculation to convert square feet into acres. What is the correct conversion factor?** (Hint: use the fact that one mile = 5280 feet, and that there are 640 acres per square mile.)

After performing the conversion, use a query to select only those sites that are at least 300 acres in size. **How many potential sites do you have? List them all in a table, rank-ordering them from largest to smallest. Include a map of the potential sites, correctly clipped to only those areas within Henrico County.**

3. Delineate Candidate Locations for Landfill

In general, when you are presenting the results of your analyses, you want to make them as neat and understandable as possible. ArcGIS has many tools that allow you to arrange a map on a page, along with annotations such as scale bars, text boxes, legends, nort-arrows, etc. Judicious use of these components can greatly enhance a map's effectiveness, and reflects well the time and effort that the analyst put into the project. Most of these annotation tools are available when looking at the map in the "Layout View" (View>Layout View).

Create a map, containing the appropriate annotations, scales, and other map details, that describes your top three picks for locating the new landfill site. In addition, create a table that lists, in rank order, your top picks, along with the size of the site and the approximate location of each site. Note: You will probably have more than three locations to choose from. Your picks for best site location will likely be based, at least in part, on considerations extending beyond the initial criteria. In other words, when faced with a multitude of choices, you will probably employ some sort of qualitative criteria, such that the largest site may not be your top pick. **In creating your "top-five" candidate list, describe how you arrived at your decision as to the order. What sorts of value judgments did you apply? Were there overriding social and/or environmental criteria that helped sway you in terms of your recommendation? Be sure to include your final map (as it would be delivered to the officials who commissioned the study). To this end, you will want to make sure that the map is as informative as possible, while still being parsimonious in its detail.**