

GIS-Based Lesson: Terrain Analysis and Fire Tower Site Location

Name: _____

Description and Objective:

Wildfires in the United States are an increasing problem. Wildland fires consumed over 7 million acres in the USA in 2002. In this lesson, you will locate the best site for locating lookout towers for firefighters to spot wildfires in the Loess Hills in the vicinity of Blair, Nebraska. To accomplish this, you will download and use a USGS Digital Elevation Model (DEM) and Digital Line Graph (DLG) from the Internet, format the data for use in ArcGIS, and create derivative data from the DEM (contour lines, a slope map, and an aspect map). You will have the opportunity to symbolize data, analyze the terrain in 3D, and locate a fire tower based on proximity to roads, rivers, elevation, and slope.

Skills Involved:

- 1) Downloading, formatting, and understanding USGS DLG and DEM data.
- 2) Creating layouts.
- 3) Tabular and spatial sort and query.
- 4) Solving a problem based on spatial analysis.
- 5) Overlay and proximity operations.
- 6) Analyzing raster and vector data together.

Software: ArcGIS 8 with Spatial Analyst and 3D Analyst Extensions, ESRI.

Downloading and Formatting a USGS DEM in ArcGIS.

In this section of the lesson, you will download a USGS Digital Elevation Model (DEM) from the Internet, format it for use in ArcMap, and analyze it.

First, create a folder named “blair,” because you will be analyzing data in Blair, Nebraska. The Loess Hills of eastern Nebraska and Western Iowa are the largest expanse of windblown silt from continental glaciation outside of China. Land of the Loess!



You need to find the county that Blair is located in so that you can go to the appropriate location to download the data. The USGS maintains a site that indicates millions of names on all of its topographic maps.

Access the following site:

<http://geonames.usgs.gov>

Go to US States and Territories and enter Blair, and limit the search to “Populated Place” field type.

Find Blair Nebraska in the listing.

1) What county is Blair in?

Now you are ready to download the DEM for Blair.

Go to the following site:

<http://www.gisdatadepot.com>

Go to the button “Download GIS Data”

Click on Nebraska.

Go to the county you indicated above and then to DEM – 1:24,000-scale.

Go to the GREEN BUTTON and access the 10 meter DEM for Blair.

This should be the file name:

[1673840.DEM.SDTS.TAR.GZ](#) (10 meter)

Save this file to your **blair** folder.

Unzip this file using Winzip. Make sure that the TAR File Smart CR/LF is OFF (unchecked). This is listed under Options→ Configuration or a similar section of Winzip.

Click “yes” if prompted “should Winzip decompress to a temporary folder”.

Access Windows Explorer.

2) What is the file extension for most of the files you just unzipped?

3) What are the four numbers that begin most of the file names? _____

The extension indicates that these files are in SDTS, or spatial data transfer standard, format. Each SDTS set of data has a unique 4 digit number. Before you can use these data, you’ll need a

translator to convert them from an SDTS-formatted DEM to a standard DEM.

Access ArcToolbox, part of ESRI's ArcGIS software, and under Conversion Tools, select "Import to Raster." Use SDTS Raster to Grid. Use the number you indicated above as the 4-digit prefix.

Name the output grid blairdemgrid and place it in your blair folder.

Use Windows Explorer to examine your blair folder.

4) What effect did the above ArcToolbox GRID creation have on the files and folders in your blair folder?

Close ArcToolbox.

Next, you will examine the coordinate system for your data. The data, as most USGS data, is in the UTM coordinate system.

For more information on the UTM coordinate system, see:
<http://erg.usgs.gov/isb/pubs/factsheets/fs07701.html>

You need to determine the zone for the data.

Go to the location:
<http://erg.usgs.gov/isb/pubs/factsheets/fs07701.html>

Scroll down to examine the UTM zones for the conterminous USA.

5) Most of eastern Nebraska is at the eastern edge of what UTM zone?

6) Access ArcCatalog, part of ESRI's ArcGIS software, and navigate to your blair folder. Examine the file blairdemgrid. Look at the file with the Preview tab. In which area of Blair are the lowest elevations?

7) What is the lowest elevation in the Blair area?

8) Under metadata, look at the Spatial tab. What UTM zone is the data in?

9) How does this compare to what you examined on the map on the USGS information sheet on the Internet, earlier?

Close ArcCatalog.

Analyzing a DEM in ArcGIS.

You are now ready to analyze your DEM and create some derivative data sets that you need to address a real-world problem.

Access ArcMap and create a new map document. Under Tools, turn on the 3D and Spatial Analyst extensions. Under View→ view the 3D and Spatial Analyst toolbars if they are not already on.

Add the Blair grid as a layer.

10) Access the projection information under the Layer Properties. What is the projection for your data?

Scroll around the DEM with the mouse, taking note of the coordinates.

11) Do the east-west coordinates increase from east to west **OR** from west to east?

12) Do the north-south coordinates increase from south to north **OR** from north to south?

13) Is Blair east or west of the central meridian in UTM zone 14?

14) Use the identify button to indicate the approximate elevation of most of the floodplain in the northeast part of the image.

Open the attribute table.

15) Is this DEM an integer grid or a floating point grid?

16) What is the most common elevation in the data set?

17) How many cells have this elevation?

18) What is the highest elevation in the data set?

19) In what part of the map is the highest elevation? How did you locate it?

Create contours from the DEM. Use the Spatial Analyst toolbar, under Surface Analysis, Contour.

20) What should your base contour be, and why?

21) Make 2 observations about the resulting contour map and attribute table, and the type of file (raster or vector) that it is.

22) Access the table for the contours layer. How many contours did you create?

Save your map document with an appropriate name in your blair folder.

Under the “surface analysis” menu again, use “compute hillshade” to create a shaded relief **from your DEM**. Save the result in your folder as a permanent file (change it from Temporary).

23) Make 2 observations about the terrain of this area of Nebraska.

If you would like to, experiment with the settings for hillshades.

24) Is the hillshade a vector or a raster file?

Use the same menu to derive an aspect **from the DEM**.

25) What does the term “aspect” refer to? Look under Arc Help, then in Contents, and scroll down to Glossary, if you need help with this or any other GIS term.

26) Is the aspect file a vector or raster dataset?

27) How many degrees on the compass is due south, based on your observations of the aspect map?

Use the same (surface analysis) menu to derive a slope map from the DEM.

28) Are the slopes in your map in degrees or as angles?

29) What is the maximum slope in the Blair quadrangle? [and you thought Cornhuskerland was flat!]



30) Describe the slopes in Blair and make two observations about the slopes in this area.

Save your map document.

Analyzing a DEM in Three Dimensions

On the 3D toolbar, access ArcScene (the last button, on the right side).

Add your DEM grid into a new ArcScene using Add Data.

Rotate and move around the terrain.

Set the heights and vertical exaggeration of the data to the surface as you did for your own DEM that you created, under Layer Properties, using the Base Heights tab.

31) Describe how you accomplished this.

32) Experiment with different z-exaggerations and indicate which you believe is most appropriate for your data.

Convert the grid to a Triangulated Irregular Network (TIN) using the 3D Analyst toolbar, and Convert→ Raster to TIN. Take the defaults.

Turn off your grid and turn on the TIN. Zoom to the full extent of it using the globe tool. Under the TIN's layer properties, use the base heights from the new TIN and experiment with the z exaggeration.

33) What z exaggeration do you feel is best to visualize the land surface?

34) Make 2 observations about the TIN.

35) Go to File→ Export Scene and create a 2D file of your TIN. Export to a JPG or other format that you can bring into MS Word or a graphics package of your choice. Import the JPG and print the file with your name and an appropriate title. Turn in with these lesson sheets.

Save your 3D scene in your folder. Close ArcScene.

Save your ArcMap map document again.

Raster Analysis

Wildland fires consumed over 7 million acres in the USA in 2002. In this section of the lesson, you will locate the best site for locating lookout towers for firefighters to spot wildfires in the Loess Hills in the vicinity of Blair, Nebraska. In the last section, you downloaded a Digital Elevation Model (DEM) from the Internet, formatted it for use in ArcGIS, and created derivative data from the DEM (contour lines, a slope map, and an aspect map). In this section, you will have the opportunity to further analyze the data you have, as well as download and analyze additional data that you'll need to choose the best location for your fire towers.

Open the map document containing the results of your analysis from the last lesson. This map document should have the Spatial Analyst extension on and the toolbar for Spatial Analyst on.

The first 2 criteria for your fire towers is that they must be located on land that is:

- (1) Over 380 meters in elevation, in order to see as much of the terrain as possible.
- (2) On a slope of less than 5 degrees, so the tower will be easily accessible by vehicles and field crews.

These are attribute selections. Examine the Selection→ Select by Attributes pull-down menu.

36) What is the only layer you can select by attribute in your folder?

Examine the table for your contours, DEM, slope, and aspect layers.

37) Why can you only select 1 layer by attribute?

Therefore, you will need a raster method to select the raster pixels that meet the criteria, that is equivalent to the select by attribute method for vector data.

Go to the Spatial Analyst pull-down menu and select the Raster Calculator. Select the elevations in the DEM that meet the elevation criteria above.

38) What expression did you use to select the elevations in the original DEM grid that meet criteria #1 above?

Note that a new grid has been created. Rename it under Properties to “Elev > 380” or a similarly appropriate name. Examine your new grid.

39) What value do the pixels have if the elevation is greater than 380 meters above sea level?

40) What value do the pixels have if the elevation is less than 380 meters above sea level?

Examine the table for your new grid to answer the following question using the counts of pixels in each category.

41) Examine the new grid's table. What percentage of the area under study is > 380 meters in elevation? Show your work.

Rename your new grid (under the general tab under Properties) to something meaningful, such as “Elevations > 380m.”

You have now solved for areas that met criteria #1 above for elevation. Now, solve for areas that meet criteria #2 above, for slope.

42) What expression did you use to select for criteria #2 for slope?

43) What percentage of the area under study is less than 5 degrees of slope? Show your work.

Rename your new grid (under the general tab under Properties) to something meaningful.

To complete the analysis, you'll need areas that are BOTH high and flat; i.e. that meet the two criteria above.

Examine the Geoprocessing Wizard under Tools to search for an intersect command to intersect the two data sets.

44) Why can't you intersect the two data sets?

Again, like the selection by attribute, since you are working with raster data, you will need to use the raster calculator to intersect your two data sets.

Access the raster calculator.

45) Recalling what you wrote above for the areas where the individual criteria were met (i.e., your expressions evaluated as "true"), write the expression you need to obtain a grid that meet the two criteria:

Evaluate your expression and rename the resulting grid to something meaningful.

46) How many pixels meet the criteria?

47) What percentage of the area under study meet the criteria? Show your work.

Recall the resolution of the data you are working with.

48) How much land area meets the criteria?

Save your map document.

The first 2 criteria for your fire towers is that they must be located on land that is:

- (1) At least 380 meters in elevation, in order to see as much of the terrain as possible.
- (2) On a slope of less than 5 degrees, so the tower will be easily accessible by vehicles and field crews.

You have solved for these criteria. The third criteria for the fire towers is that they must be:

- (3) Within 100 meters of a river, so that the crew has access to at least some water for wildfire management.
- (4) Within 50 meters of a road, so that they are accessible to field crews and vehicles.

To meet criteria 3 and 4, you will need to download river and road vector data from the Internet. This will give you practice downloading, formatting, symbolizing, and analyzing a new data set, the USGS Digital Line Graphs, as well as give you additional practice in using vector and raster data together.

Downloading digital spatial data from the Internet and reformatting it is a key skill in working with GIS. The following steps, as most GIS activities, require you to be an excellent data manager--knowing the location of your data and programs is essential.

Downloading Digital Line Graph (DLG) Data and Formatting for Use in ArcGIS

Make a subfolder underneath your blair folder and name it dlgs.

Now you are ready to download the data from the USGS GeoData site at the Earth Resources Observation System (EROS) Data Center:

<http://edcwww.cr.usgs.gov/pub/data/>

Go to the above site and then:

Go to DLG

Go to 100K

Go to B (because you are examining Blair)

Once on this page, perform a FIND (usually a Control-F) to quickly locate Blair Nebraska in the list.

Notice that there is a Blair East and a Blair West. The DLG 1:100,000-scale data is distributed in 2 blocks, one for the east half of the Blair 1:100,000-scale block and one for the west half. The DEM data you have been examining thus far covers the city of Blair and immediate surroundings. You will need to determine which half the city of Blair and immediate surroundings are in.

Open a new web browser window.

Go to <http://geonames.usgs.gov> This is the listing of all of the several million feature names found on USGS topographic maps. Search on Blair, Nebraska as a populated place.

49) What is the latitude and longitude of the city of Blair?

Go to the online map indexes on www.maplink.com to determine which half of the Blair block you need to access.

After accessing the Maplink site:

Go to: USGS Topographic

Go to: Index Image

50) What state should you go to?

Zoom in until you see the 1:100,000-scale blocks.

You should be on the page: <http://catalog.maplink.com/usgs/ne100k.html>

51) What longitude does the Blair 1:100,000-scale block cover?

52) How large, in degrees, is the Blair 1:100,000-scale block?

53) Therefore, how large, in degrees, will the Blair East and the Blair West half of the 1:100,000-scale block be?

54) Based on what you determined to be the longitude of the town of Blair, in what half of the Blair 1:100,000-scale block is the town located? East or West?

Go to the web browser that is pointed to the USGS EDC site where the DLG data is located:
<http://edcwww.cr.usgs.gov/pub/data/DLG/100K/B/>

Go to Blair East or Blair West, depending on your answer, above.

Go to Hydrography

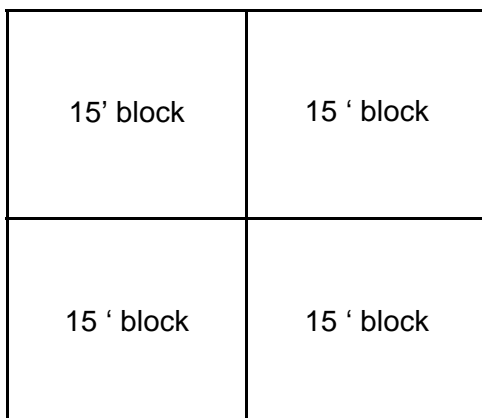
55) How many blocks of data end with an opt.gz extension (not the SDTS extension)?

These four blocks make up half of the Blair 1:100,000-scale block.

56) Since each degree is made up of 60 minutes, how many **minutes** does each block cover?

Examine the following schematic map to visualize the extent of your data.

Blair East



Download the following 4 hydrography files into your DLG folder.

[482364.HY.opt.gz](#)
[482367.HY.opt.gz](#)
[482368.HY.opt.gz](#)
[482369.HY.opt.gz](#)

Use your web browser to go BACK to the list of layers for Blair East.

Go to the Transportation layer and save the following files to the same folder as above (DLG):

482386_RD.opt.gz
482387_RD.opt.gz
482391_RD.opt.gz
482392_RD.opt.gz

Next, you are ready to uncompress the data, after you check a setting in WinZIP.

In WinZip, go to:

WinZIP classic

Find "Options" or "Preferences"

Miscellaneous

Configuration

Make sure that "TAR file smart CR/LF conversion" is turned **off** (not checked).

Select OK.

Close WinZip.

Access Windows Explorer and navigate to your directory where you have saved the zipped files. Double-click on one of the .gz files. Winzip should automatically be accessed.

If you receive this message: Decompress to a temporary folder and open it? → YES

Extract all 8 .gz files into your folder.

57) How many files were zipped in each of the .gz files? _____

58) How many feature files contain hydrography? _____

59) How many feature files contain roads? _____

Next, you need to rename the files so they are (1) easier to work with, (2) reflect the correct geographic location of the data in the Blair East block, and (3) so that your ArcToolbox conversion routine will work (it requires the .dlg extension on the files).

Use Windows Explorer to rename the files to the "to name" as follows:

<u>From Name</u>	<u>To Name</u>
482364.HY.opt	blair1hy.dlg
482367.HY.opt	blair4hy.dlg
482368.HY.opt	blair2hy.dlg
482369.HY.opt	blair3hy.dlg
482386.RD.opt	blair1rd.dlg
482387.RD.opt	blair3rd.dlg
482391.RD.opt	blair4rd.dlg
482392.RD.opt	blair2rd.dlg

The file listing on http://edc.usgs.gov/geodata/old_vs_new_name_opt.txt is where the above file names were obtained.

By renaming, you are turning the confusing naming convention from the FTP Internet site to one that makes more sense. You are naming the files in the northwest quarter of the block as "1", the NE as "2", and so on, as seen in the schematic map, below.

Blair East

1	2
3	4

To summarize the steps you've gone through thus far to bring DLG data to the point where you can work with it in a GIS environment, you:

- [1]. Downloaded and unzipped the hydrography and roads DLG data for Blair.
- [2]. Renamed files to reflect their geographic location and to enable ArcView to recognize them.

The data are not quite ready to use in ArcGIS yet. You will need to import them using ArcToolbox.

60) Using the NW square as an example, write the correct file names in the correct locations below. The northeast quadrant is quadrant "2", southwest is "3", and southeast is "4."

Blair East

blair1hy.dlg blair1rd.dlg	

Convert DLG files to ESRI Coverages

Access ArcToolbox.

Conversion Tools.

Import to Coverage.

DLG to Coverage Wizard.

Take the defaults and do not create any point coverages. Name your final output coverage the same name as the input dlg file, but without the dlg extension. For example, blair1hy.dlg converts to blair1hy coverage.

61) How many times will you have to run the DLG to coverage wizard?

Run the DLG to coverage wizard the required number of times.

When complete, exit ArcToolbox.

Go to ArcMap and access your blair.mxd map document.

Add all of your DLG themes as ARCs (lines).

62) Why do you want to analyze these layers as lines instead of polygons?

Merging Themes

You have been preparing hydrography and transportation DLG data for spatial analysis in ArcGIS.

63) How many blocks of Blair data have you brought to ArcGIS?

64) What is the size of these blocks? Circle your answer:

7.5-minute

15-minute

30-minute

1-degree

You have been working these blocks as separate layers. Sometimes, layers are merged into one layer covering the whole geographic area to facilitate spatial analysis. That is what you will have the opportunity to do in this section.

In ArcGIS, before layers are merged, you should check the number of fields the attribute tables have so that none are skipped. In the next section, you will do this.

Start by examining one of the attribute tables. DLGs are attributed by major/minor pair. Each pair contains a code that indicates a particular attribute about the feature.

If a DLG contained the fields major1, minor1, major2, and minor2, it is said to have **two** major minor **pairs**.

Some DLGs have only 1 major/minor pair, while others may have 5 or more.

For example, Colfax Avenue in Denver might have a major/minor pair indicating it is a class 1 road, another pair to indicate it is US 40, another pair to indicate that it is undivided, and another pair on a certain segment to indicate that it is an underpass (such as when it passes underneath Federal Blvd near Invesco at Mile High Stadium, for example).

Before you merge your DLG data, check your DLG files to determine which one has the most fields. This is the file you will use as the “template” when you merge.

For example:

If two layers, A and B, will be merged, and Layer A has 1 major/minor pair, and Layer B has 2 major/minor pairs, then you want the final merged result to have 2 pairs.

65) One at a time, open the table of each layer. Fill in the following data.

Layer	Number of major/minor pairs	Number of records (rows in the table)
blair1hy		
blair2hy		
blair3hy		
blair4hy		
blair1rd		
blair2rd		
blair3rd		
blair4rd		

As a hypothetical example, say Layer A, B, C, and D will be merged:

Layer A has 2 pairs.
Layer B has 1 pair.
Layer C has 3 pairs.
Layer D has 2 pairs.

All layers will therefore need to have 3 pairs, the maximum number in the data set.

66) For Blair, what roads layer should be used as the template?

67) Why?

68) What hydrography layer should be used as the template?

69) Why?

Now you're ready to merge the 4 hydrography blocks into 1 block, and the 4 roads blocks into 1 block.

Use Tools→ GeoProcessing Wizard to merge your data. Remember your answers above to fill in the "use fields from" space in the wizard.

Name your merged hydrography file: blairhy.shp
Name your merged roads file: blairrd.shp

70) What type of files do you now have: coverages or shape files?

Access the table for blairhy

71) How many features (records) does it have?

72) Compare this answer with your answer to number of features you listed for the separate hy1, hy2, hy3, and hy4 themes. Explain why blairhy.shp has the number of records that it has:

73) Click on identify button (on far left) and then click on an external or internal neatline [map area border]. What are the major/minor values for the neatlines?

74) Why is it now safe to remove the separate layers blair1hy, blair2hy, blair1rd, etc?

Save your map document.

Access the table for blairrd – the roads for Blair.

75) How many features (records) does it have?

76) How many major/minor pairs does it have?

77) Do you still see the neatlines (outer lines) for the individual original 15-minute blocks?

78) What are the attributes for these lines?

Symbolizing Data

Change the symbology to “unique value.”

Change the values field to “minor1.” You will see the major and minor code fields.

Minimize [don’t cancel] ArcMap.

Access your web browser.

Go to mapping.usgs.gov

GeoSpatial Data Standards

DLG

Part 3 Attribute Codes

Open the Adobe Acrobat PDF file:

rockyweb.cr.usgs.gov/nmpstds/acrodcs/dlg-3/3dlg0798.pdf

Go to page 110 in the Acrobat file and find the attribute codes for roads and hydrography. Use the information you find here to change the symbols in ArcView so that major roads and major rivers are wider or different line symbols than the minor roads and rivers. At a minimum, create 3 separate symbols for hydrography and 3 separate symbols for roads.

Remember when you choose your symbols that the output device in your laboratory may be a black and white printer. Therefore you might want to change the line type rather than the line color.

79) What is the difficulty in symbolizing data based on the major/minor coding scheme?

80) Under Symbology, make a unique value, many fields map. Use Minor1, Minor2, and Minor3 for the field names. Compare the result to your unique value map that used just one field.

81) Create and print a layout of your symbolized data, and include your name, a legend, the data for hydrography and roads, and a scale bar.

Save your map document.

The extent of your hydrography and roads data is larger than the area you are considering for your fire towers.

You need to clip the extent of the hydrography and roads to the extent of the DEM and the data that you worked with at the beginning of this lesson.

82) Examine the choices under Tools→ Geoprocessing Wizard. Is clip one of the choices?

Similar to the situation you encountered with other functions at the beginning of this lesson, you cannot clip unless you have a vector data set demarking the area of interest. You can create one

from any of the raster files, however. This will define the area to which you will clip the roads and hydrography.

Use the raster file that with elevations above 380 meters.

On this layer, Use Spatial Analyst → Convert.

83) Which choice underneath convert is appropriate for what you want to do?

Use this choice to convert your file and name it blairextent.

84) What type of file is the result—raster or vector?

Now, use the geoprocessing wizard to clip your roads to just the extent covered by your new bliarextent vector file. Name the result blairrdclip. Do the same for hydrography and name the result blairhyclip.

85) Would you expect **more** or **less** features in the resulting clipped file versus the original file? Circle your answer.

More

Less

Examine your attribute tables.

86) How many features are in the resulting Blair roads clipped file?

87) How many features are in the resulting Blair hydro clipped file?

Raster and Vector Analysis: Fire Tower

Now you are ready to use your data to refine your fire tower analysis.

Recall your third and fourth criteria on the fire tower:

(3) Within 100 meters of a river, so that the crew has access to at least some water for wildfire management.

(4) Within 50 meters of a road, so that they are accessible to field crews and vehicles.

Before you create the areas near roads and rivers, notice that some of the rivers and some of the roads are not truly rivers and roads. Rather, they are the outer boundary of the map, or the “neat line.”

88) What MAJOR1 attribute do these neatlines have?

Select the neatlines in the roads layer using Select By Attribute and the MAJOR1 code you identified above. Then, switch the selection so you are selecting all of the OTHER features, in other words, the “true” roads.

89) Using the buffer wizard, explain how you generated a buffer for roads that meets the criteria, above. Be sure to only buffer the selected (true) roads.

90) How many polygons are in your roads buffer file?

Next, select the neatlines in the rivers layer using Select By Attribute and the MAJOR1 code you identified above. Then, switch the selection so you are selecting all of the OTHER features, in other words, the “true” rivers.

91) Using the buffer wizard, explain how you generated a buffer for rivers that meets the criteria, above. Be sure to only buffer the selected (true) rivers.

92) How many polygons are in your rivers buffer file?

93) Using the Geoprocessing wizard’s intersect function, explain how you generated a single vector layer that meets **both** the third and fourth criteria, above. Do not dissolve the polygons between buffers. Name your resulting shape file river100_road50.

94) How many polygons are in your final river and roads buffer intersection file river100_road50?

Save your ArcMap map document again.

To meet all 4 criteria for the fire tower, you’ll need to intersect your file containing (A) areas near rivers and roads with (B) the map you created earlier that contained flat and high areas. You cannot do this without one more conversion. You’ll either need to perform the final analysis in the vector model or the raster model.

95) Is (A) a raster or vector file?

96) Is (B) a raster or vector file?

First, you will convert your high and flat areas to a vector file. Then, you will intersect this high and flat vector file with your file that contains areas close to roads and close to rivers.

Before you convert your high and flat areas to a vector file, you will need to select the areas that are truly high and flat.

Access the table for your high and flat raster file.

97) What is the value of the areas that are high and flat?

Using Select By Attributes, select the areas in the high and flat file that are truly high and flat.

Using Spatial Analyst → Convert, convert the high and flat dataset to a vector dataset. Give it an appropriate name and place it in your blair folder.

98) How many polygons exist in this new dataset?

Using Tools → Geoprocessing Wizard, intersect your high and flat areas with the areas close to rivers and roads.

Name the output file firetowersites.

Save your map document.

99) How many potential sites (polygons) can you consider for your fire towers?

Create a layout of your final fire tower sites. Print the layout and include a legend, other layers for reference, your name, and other information that you feel is important.

100) Summarize in a few sentences what you have learned about locating a fire tower in this lesson.

101) Summarize in a few sentences what you have learned about GIS analysis tools in this lesson.

*** End of Terrain Analysis and Fire Tower Lesson ***