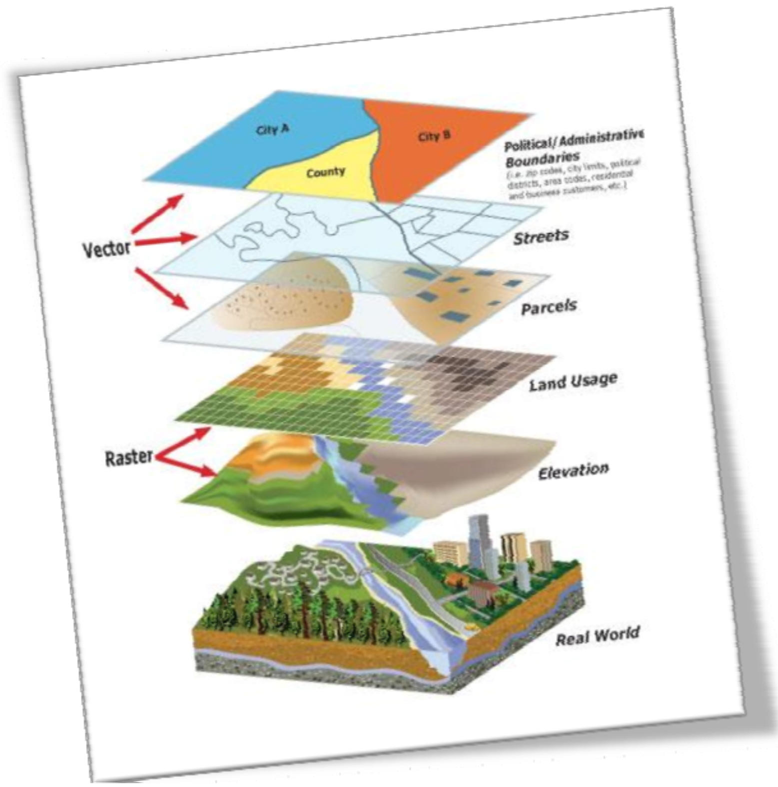


ES 341 – Geographic Information Systems

Winter 2013
Dr. Taylor
Assignment Portfolio

Prepared By:
Kathryn Roberts

January 25, 2013

Kathryn Roberts
01/07/13

INTRODUCTION TO TOPOGRAPHIC MAPS

c:\wou\geomorph\f2000\introlab.wpd

All of the following questions refer to the Monmouth, OR Quadrangle.

1) What is the fractional scale, contour interval, and magnetic declination of this map?
a) Scale: 1:24,000 b) Contour Interval: 10 ft c) Declination: 19°E

2) What quadrangle maps are located immediately adjacent to the Monmouth Quad.?
a) North: Rickreal b) South: Lewisburg c) East: Sidney d) West: Airlie North

3) What is the quadrangle size series of this map (in long. and lat.)?
7.5 min

4) What is the date of publication of this map?
1970 (photo revised 1986

5) What does the tick with 4956000m N. mean? (lower right of map)
UTM demarcation

6) What is the name of the major fluvial system flowing through this area. Of What larger drainage basin(s) does this river form a part of?
Williamette River, Columbia River Basin

7) What is the approximate elevation of the Natural Sciences Building based on the map representation? 210 ft

8) Given the fractional scale determine the following
1 in = 24,000 in 12 in = 1 ft 5280 ft = 1 mile
5 inches on the map= 10,000 Feet on ground = 1.89 Miles on ground.
10 inches on the map= 6097.6 Meters on ground = 6.098 Kilometers on ground.
3.28 ft = 1 m 1000 m = 1 km

9) A. What is the road distance in miles along Rt. 99 between Helmick State Park and Monmouth city limits? $= 13\text{ in} \times 24{,}000 = 312{,}000\text{ in}\left(\frac{ft}{12\text{ in}}\right)\left(\frac{mi}{5280\text{ ft}}\right) = 4.92$ miles

B. What is the distance in kilometers?
$4.92\text{ mi}\left(\frac{5280\text{ ft}}{1\text{ mi}}\right)\left(\frac{m}{3.28\text{ ft}}\right)\left(\frac{km}{1000\text{ m}}\right) = 7.93$ km

10) A. Determine the average stream gradients (in Ft/Mi) for the following drainages:

A. Willamette River: Gradient: 177 − 153 = 24 ft Length: 105 − 93 mi = 12 mi 24 ft/12 mi = 2 ft/mi
B. Luckiamute River: Gradient: 212 − 157 = 55 ft Length: 13 − 5 mi = 8 mi 55 ft/8 mi = 7 ft/mi

11) A. What is the highest point of elevation represented on this map? 880 ft

B. What is the lowest point of elevation represented on this map? 150 ft

C. What is the maximum relief. 880 ft − 150 ft = 730 ft

12) A. What is the longitude and latitude location of the road intersection at Buena Vista
44° 46' 10", 123°, 65' 47"

.5'/.55" (3.3") = 1.15'

B. What is the longitude and latitude location of Davidson Hill?
44° 45' 59" 123°, 11' 15"

.5'/.375" (3.7") = 1.713'

C. What is the straight line distance in miles between these two points?
$5\text{ in} \times 24{,}000 = 120{,}000\text{ in}\left(\frac{ft}{12\text{ in}}\right)\left(\frac{mi}{5280\text{ ft}}\right) = 1.89$ miles

D. What is the azimuth bearing FROM Davidson Hill TOWARDS Buena Vista?

085°

E. What is the quadrant bearing FROM Buena Vista TOWARDS Davidson Hill?

S85°W

13) A. What is the nature of the topographic slope in the vicinity of the town of Monmouth?

gently sloping

C. What is the local relief between WOU and the Willamette adjacent to Independence?

210 − 150 = 60 ft

D. Is the outline of the topography east of Independence relatively arcuate or irregular in outline?

irregular

E. What processes might have formed the pattern in D above?

possibly landslides or unstable hill slopes

14) Examine the cultural activity immediately north of Monmouth and Independence.

A. Write a brief assessment of the potential for environmental degradation to the surface and groundwater of this area. List three types of water quality degradation (i.e. contamination) problems that may exist in this area.

One source of environmental degradation that is likely is from agricultural runoff in the area, as agriculture is the predominant land use in the area.

A second source of environmental degradation that may occur is from urban runoff from the the urban sections of the map (the Monmouth / Independence areas)

a third source of potential water contamination that may occur is from industrial runoff from anthropogenic industrial activity in the area & urban center [illegible].

18. Determine the elevations of the following locations:

A. Wigrich 260 ft.

B. Oak Hill (SC) 476 ft

C. Dicker Reservoir (NE) 450 ft

D. Davidson Bridge (SC) 160 ft

19. Draw a topographic profile along a line connecting Oak Hill (SC) to Vitae Springs. Use a horizontal scale of 1 in = 4000 Ft, and a vertical scale of 1 in = 333.33 ft (see attached profile paper).

A. Determine the minimum slope grade represented on the profile in percent.

1% Williamette River to Burlington Northern

B. Determine the maximum slope grade represented on the profile in percent.

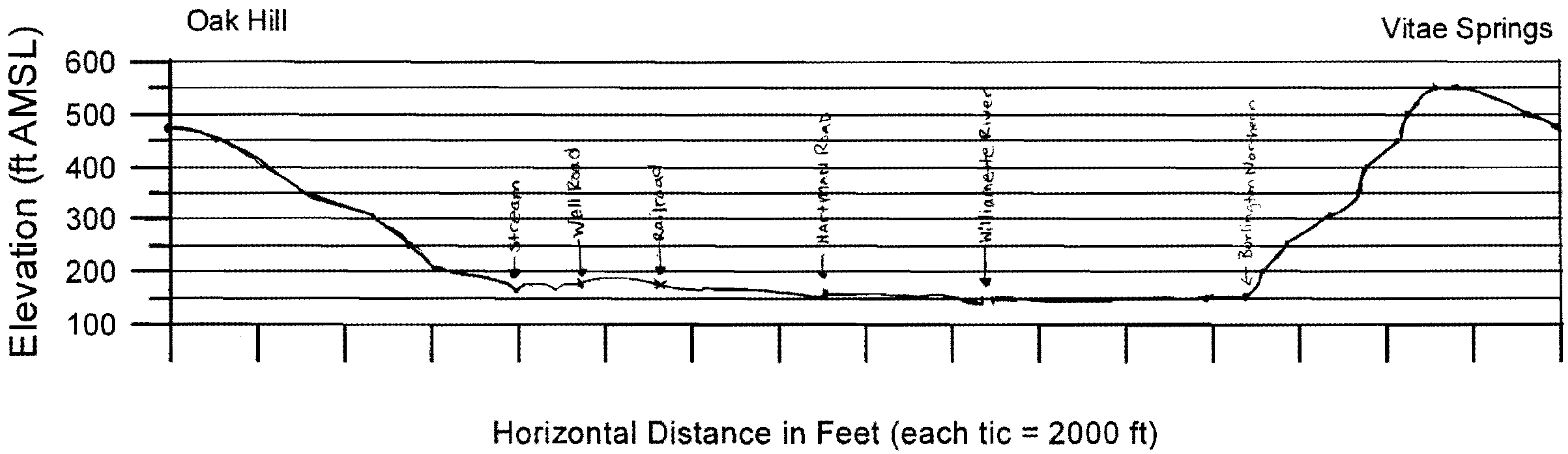
9% Burlington Northern to Vitae Springs

C. Where are the areas most likely associated with flooding?

Williamette River & adjacent

D. The vertical exaggeration of a profile is calculated by: VE = H scale / V scale; Calculate the vertical exaggeration represented on the attached profile.

Topographic Profile from Oak Hill to Vitae Springs, Monmouth, OR Quad.



Horizontal Scale: 1 in = 4000 ft
Vertical Scale: 1 in = 333.33 ft

V.E. = H/V = $\frac{1/4000}{1/333.33}$ .0833 ft/ft V.E.

c:wou:geomorph:monblank.grf

ES341 In-Class Exercise – Conversion of Longitude and Latitude Name Kathryn Roberts

01/07/13

Convert the Following Locations in Lat-Lon to Decimal Degrees (show all your math work)
(given conversions: 1 deg = 60 min; 1 min = 60 sec; 1 deg = 3600 sec)

	Lat	Dec. Deg	Long	Dec. Deg.
Seattle	47°36'40" N	47.611	122°20' 57" W	122.349
Honolulu	21°18'22" N	21.306	157°50'10" W	157.836
New York	40°30'43" N	40.519	73°58'32" W	73.976

Seattle = $36' \frac{°}{60'} = .6 + \left(40" \frac{°}{3600"}\right) =$

Convert the following locations in Decimal Degrees to degrees-minutes-seconds

Lat		Long		Approximate Location?
25.7532° N	25° 45' 12"	80.2376° W	80° 14' 15"	Florida
53.2356° N	53° 14' 8"	9.0034° W	9° 0' 12"	England
60.487° N	60° 29' 13"	5.3357° E	5° 20' 8"	Norway

.7532 × 60 = 45.192 = 45'
.192 × 60 = 11.52"

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01/10/13

ES492/592 GIS Applications
In-Class Exercise: Introduction to Contouring and Digital Elevation Models

Examine the attached map figures. Fig. 8.10 shows a visual 3-D model of the Earth's surface and the depiction of corresponding topographic contour lines that connect points of equal elevation.

Task 1. Using the spot elevation data depicted in Fig. 8.11 A and B, contour each map using a contour interval of 10 feet. Map A will include lines 480, 490, 500, 510, 520. Map B will include lines 90, 100, 110, 120, 130, 140.

Task 2. Using the bar scale and a ruler, calculate the fractional scale of the maps in Fig. 8.11.

1.651 cm = 10 m   10 m (100cm / m) = 1000 cm   1.651 cm / 1.651 cm = 1000 cm / 1.651 cm = 1 cm = 605.7 cm = **1:605.7**

Task 3. Create a rasterized digital elevation model for your contour map. Easting (X position in meters) and Northing (Y position in meters) coordinates for the corners of Map A are as follows:

NW corner coordinates = 1,463,243 m, 538,275 m
SE corner coordinates = 1,463,293 m, 538,243 m

3A. Calculate the total East-West distance covered by map A in meters = 50 m
3B. Calculate the total North-South distance covered by map A in meters = 32 m

3C. Our goal is to create a raster grid to overlay map A with a cell resolution of 2 meters. Given the map boundaries and dimensions listed above, determine the number of grid rows and columns that will be required to divide the map into 2 m grid cells.

N-S No. Rows = 16

E-W No. Columns = 25

3D. Measure the map dimensions in inches: E-W Distance = 3.23 inches N-S dist = 2.05 inches
(E-W) (N-S)

3E. Calculate the map-scale dimensions of each 2-m grid cell in inches = .13 X .13 (in)

3 F. Starting at the North edge, and East edge of map A, draw a series of rows and columns to scale, that depict a 2-m grid overlay on the map.

3G. Now for each cell on the map, interpolate an elevation and classify the grid cell according to the following scale (use color pencils to carefully color each cell, STAY IN THE LINES):

480-490 ft elev. = Blue
490-500 ft elev. = Green
500-510 ft elev. = Yellow
510-520 ft elev. = Red

Task 4: You did it! You have now overlain a rasterized 2-m Digital Elevation Model on top of a vectorized contour map. Provide a brief discussion of the differences between vector and raster data models.

The vector map provides specific features of the landscape (like elevation through contour lines). The raster data model applies a specific geographic location & allows for further landscape classification using GPS coordinates (UTM in this example).

PACKET 11

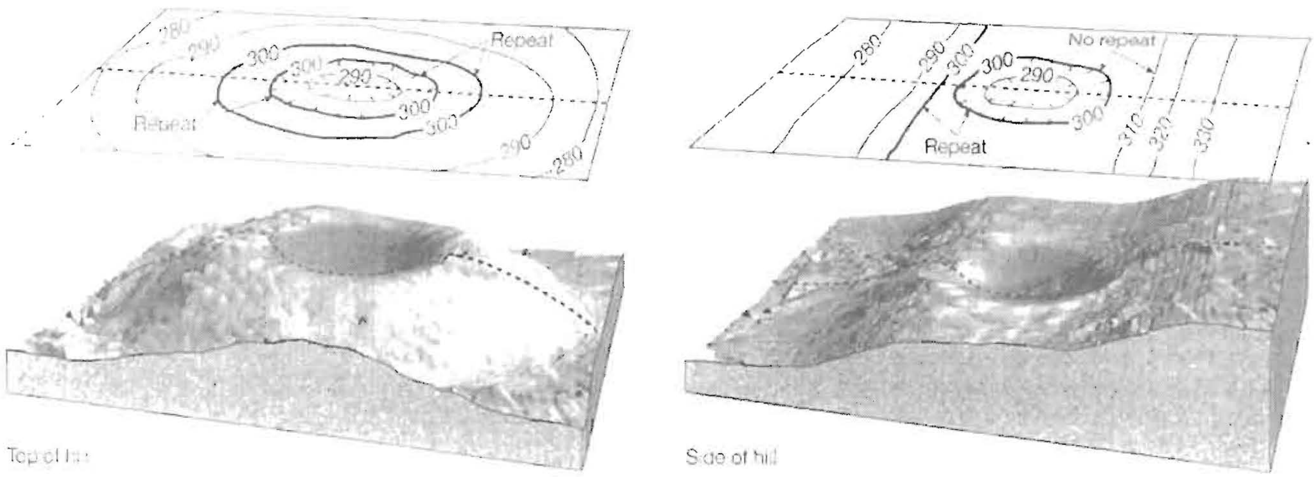

FIGURE 8.10 Contour lines repeat on opposite sides of a depression (left illustration), except when the depression occurs on a slope (right illustration).

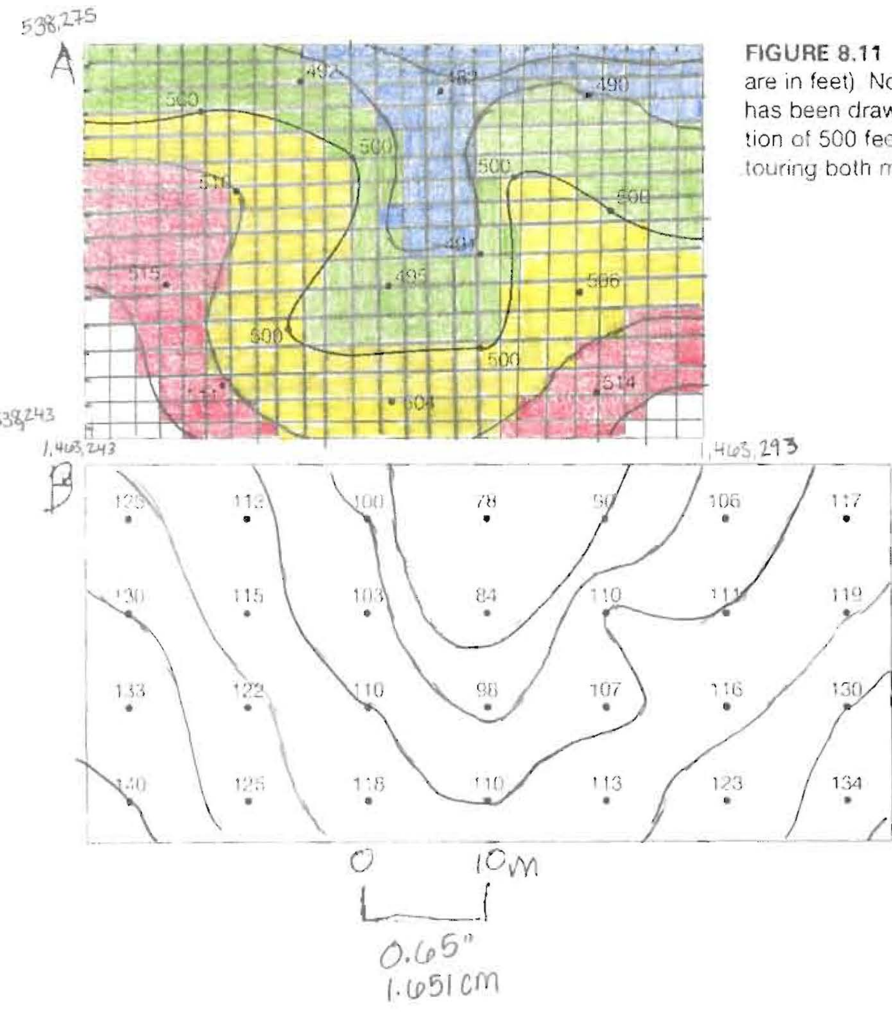

FIGURE 8.11 Topographic map construction (elevations are in feet). Notice in map **A** that a 500-foot contour line has been drawn through all the points that have an elevation of 500 feet above mean sea level. Can you finish contouring both maps using a contour interval of 10 feet?

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01/10/13

GIS INTRODUCTION TO RASTER GRIDS AND VECTOR MAP ELEMENTS
c:wou:nssi:vecrasex.wpd

Purpose: To explore the raster grid and vector map element concepts in GIS.

PART A. RASTER GRID NETWORKS

Task A- 1 Examine the attached topographic map (Figure 1). The contour lines are displayed with UTM Northing and Easting coordinates. Answer the following preliminary questions.

1-1. What is the contour interval of the topographic map? (assume that elevation units are in feet AMSL)
5 ft.

1-2. The UTM Coordinate system is in what unit of distance measurement?
Meters

1-3. Determine the UTM coordinates for the following point locations:

	X (Easting) meters	Y (Northing) meters
Point A	3200 m	14,750 m
Point B	7,900 m	9,700 m

1-4. Determine the following map boundaries relative to the UTM Easting / Northing coordinate system (fill in the chart below).

Maximum X (Easting) coordinate of map 10,000 m
Minimum X (Easting) coordinate of map 1,000 m
Maximum Y (Northing) coordinate of map 16,000 m
Minimum Y (Northing) coordinate of map 9,000 m

Total X unit distance displayed on map 500 m
Total Y unit distance displayed on map 500 m

1-5. Observe the grid overlay on the topographic map. Where each of the grid lines intersect, this point is referred to as a "node". Determine the following:

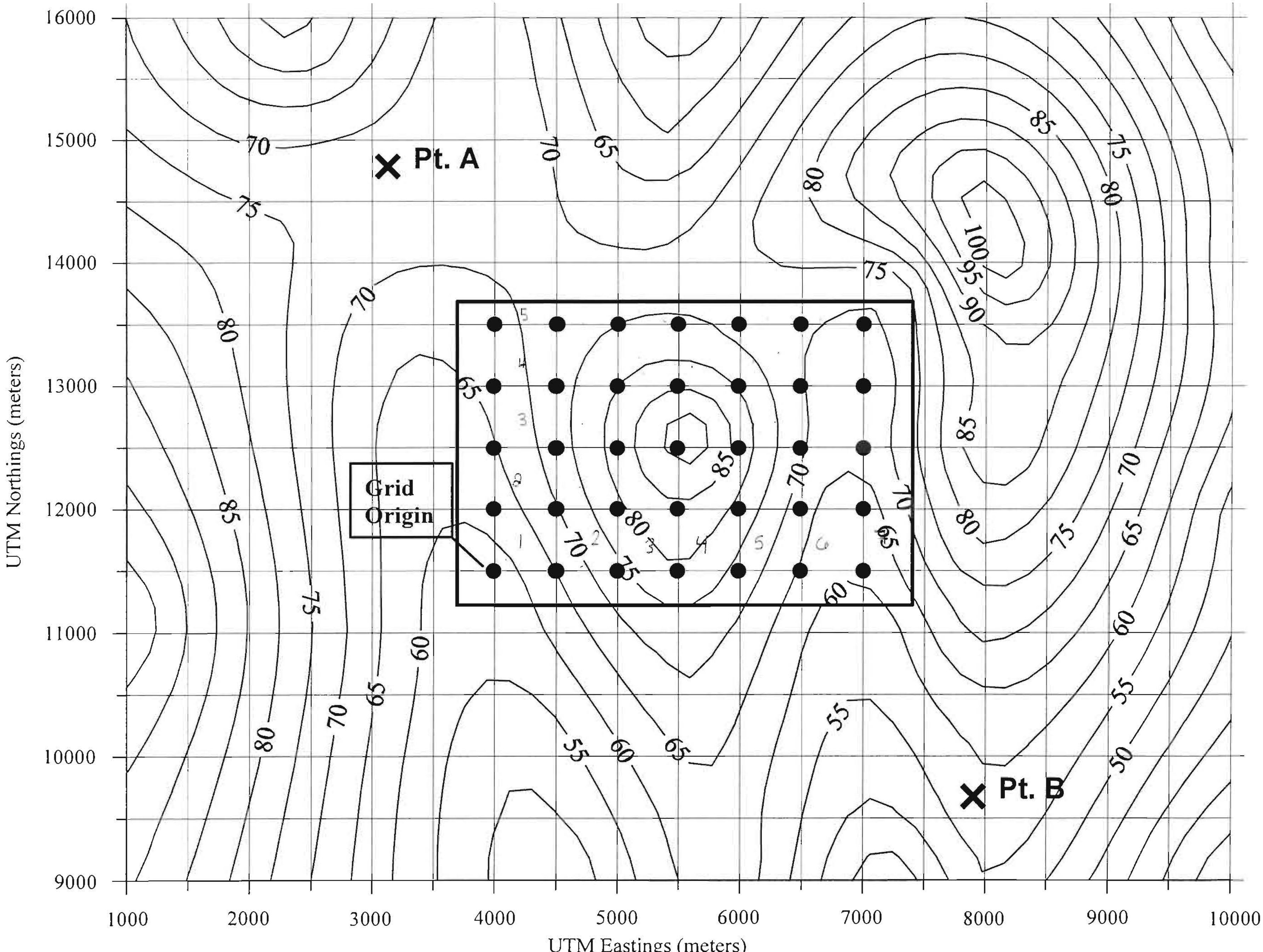
How many total rows of grid lines do you observe on the map? 8
How many total columns of grid lines do you observe on the map? 10

Divide the total X unit distance (from 1-2) by the number of columns 71.4
Divide the total Y unit distance (from 1-2) by the number of rows 100

What is the X unit distance covered between each node? 500
What is the Y unit distance covered between each node? 500

Are the nodes distributed on a perfectly square or rectangular grid network? rectangle

Figure 1. Example Topographic Map with Grid Overlay



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1-6. Consider a hypothetical example (not related to the attached figure). Assume the following map coordinate relationships:

Maximum X (Easting) coordinate of map	15,000 m
Minimum X (Easting) coordinate of map	13,000 m
Maximum Y (Northing) coordinate of map	8000 m
Minimum Y (Northing) coordinate of map	6500 m

Your goal is to create a "10 m" grid for this hypothetical map (i.e. 10 m between each grid node).

What is the total X distance covered on the map? 2,000 m

What is the total Y distance covered on the map? 1,500 m

How many grid line rows do you need to specify? 15

How many grid line columns do you need to specify? 20

Task A-2. Raster data in geographic information systems is basically a grid network of data, with X,Y node coordinates and a "Z" value (i.e. some attribute) attached to each node point. In the case of "digital elevation models" (also known as DEM's), the "Z" attribute value is elevation relative to sea level. Your task here is to create a digital elevation model (gridded elevation data) for the area selected on the Figure 1, as outlined with the dark rectangle in the center. The selected nodes are highlighted with a heavy "dot".

- Assume that the first row and first column of the grid starts in the lower left hand corner (i.e. the southeast corner of the marked grid). This point is marked as "grid origin" on the map. This is analogous to a Cartesian coordinate system used in mathematical graphing. Fill in the following charts:

Easting Coordinates

Column 1	4250
Column 2	4750
Column 3	5250
Column 4	5750
Column 5	6250
Column 6	6750
Column 7	7150

Northing Coordinates

Row 1	11,750
Row 2	12,250
Row 3	12,750
Row 4	13,250
Row 5	13,500

Gridded Elevation Data (fill in the elevations for each node on the grid, interpolate elevations as needed)

Columns

Row	1	2	3	4	5	6	7
1	63	73	80	80	72	64	65
2	67	76	85	85	75	65	67
3	70	77	86	88	77	70	72
4	70	75	78	77	74	70	72
5	70	70	74	74	72	70	72

Concluding Statement to Part A Raster Grids

You now have an understanding of how raster grid data is created and stored in Geographic Information Systems. The study area is divided into a mesh of grid cells, with each node attached to some attribute information (i.e. "Z" values). Each cell is given a numeric identifier or value. Raster systems are good for representing data over continuous space, examples include:

Digital pictures or images (each cell is assigned a color value, here a cell is called a "pixel")
Digital Elevation Models (each cell is assigned an elevation)
Rainfall Maps (each cell is assigned a rainfall value - inches of precipitation accumulated over time)
Vegetation maps (each cell is assigned a vegetative index number)

Last Question: Think up three examples of spatial map data, other than the examples listed above, that could employ digital raster techniques.

Idea 1 population density

Idea 2 animal biodiversity

Idea 3 rock lithology

PART B. VECTOR MAP REPRESENTATION

Vector map elements represent map data as a collection of points, lines, and polygons. Below are geometric definitions of each as related to digital map elements (see **Figure 2** for Examples).

Points - individual points in map space represented by a very specific X, Y coordinate.

Straight Line Segments - straight lines that connect any two points (represented by two pairs of X,Y coordinates).

Polylines - lines with multiple segments of differing orientation (multiple sets of X,Y coordinates)

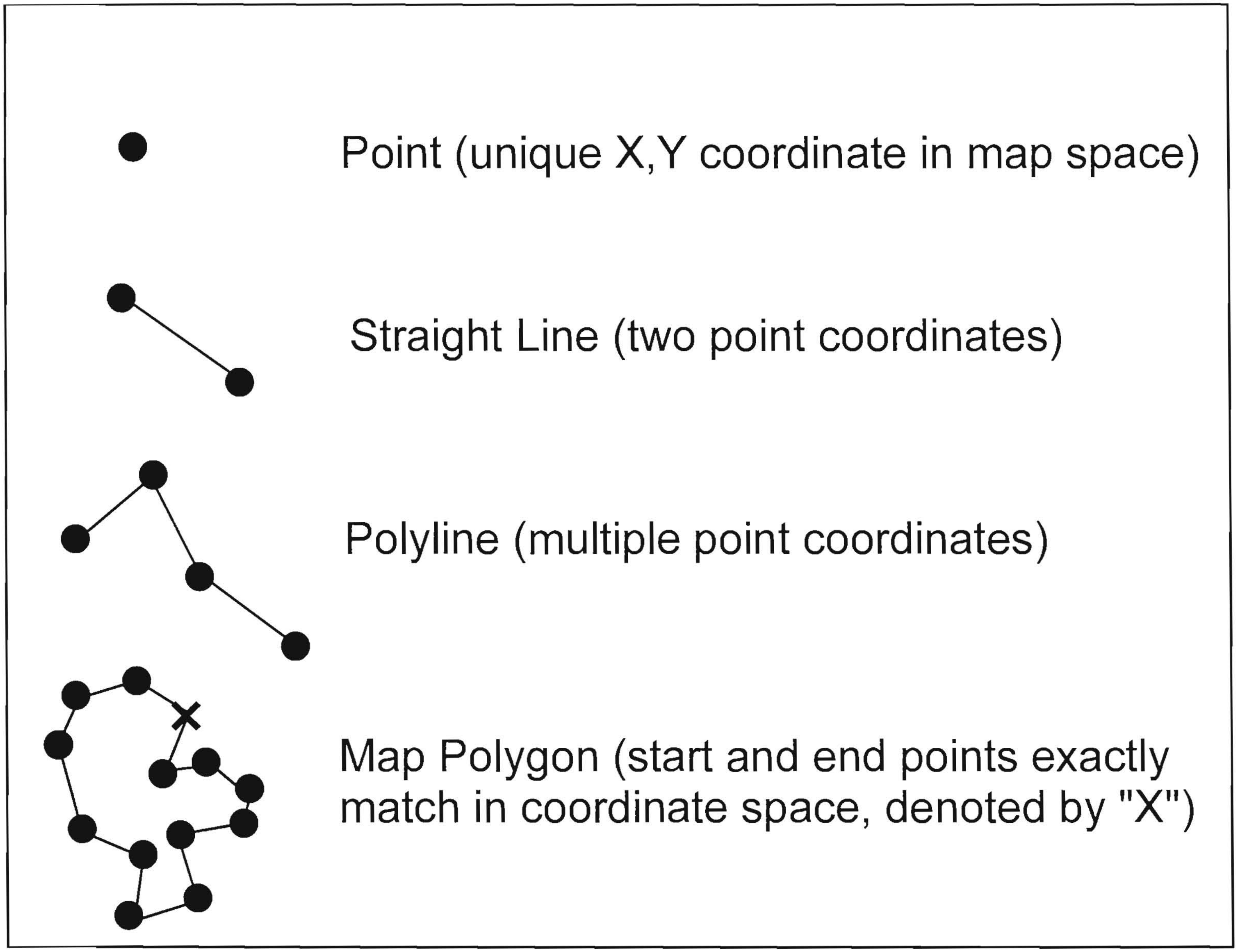
Polygons - regular to irregularly shaped polyline sets that completely close on themselves (i.e. the end point of the polyline exactly matches the origination point of the polyline).

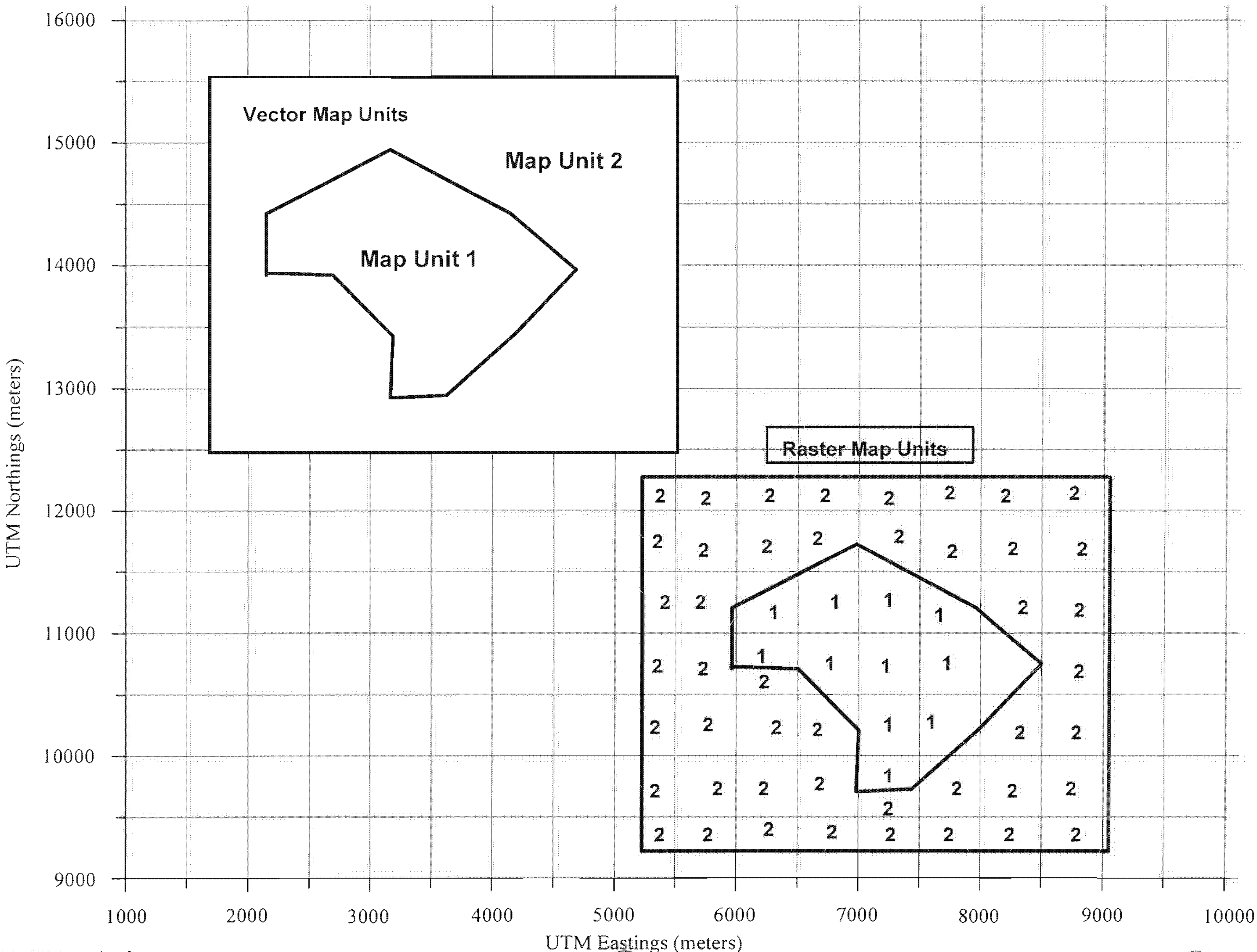
***A Side Note:* In the case of the vector approach to map elements, two software files are required: (1) a vector graphics file with the geometric coordinates and map element types. Here the map element is assigned an internal code, and (2) a database information file that links attributes to the internal code of the map elements. This is different than the raster grid data structure above, in which all data can easily be stored in one data file. Hence, vector map layers usually require multiple data files to manage the same information that one raster data file represents.**

Examine Figure 2A for a comparison of polygon map elements represented in a vector vs. raster data structure.

c:nssi:mapelmnt.srf

Figure 2. Vector Map Elements





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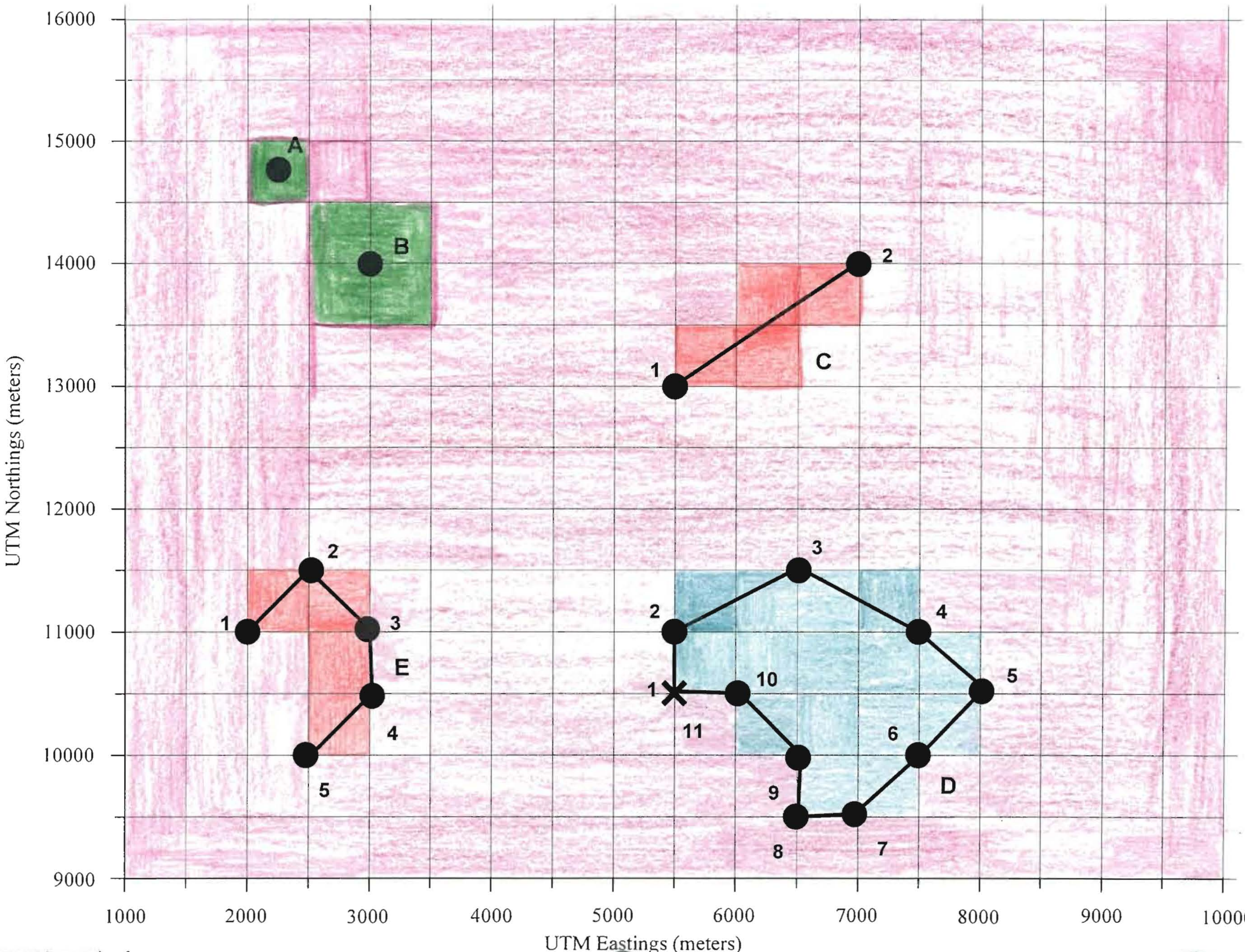
Task B-1. Refer to Figure 3. This is a map grid in UTM-meters, with several digital map features listed A through E. Identify which type of map element is represented by each feature in the table below (point, line, polyline, or polygon).

Feature	Map Element Type
A	point
B	point
C	straight line
D	polygon
E	polyline

Task B-2. Build a vector data file for each map feature (A through E) in the table below.

Feature	Node Coordinates	
	X coordinate	Y coordinate
A	2250	14750
B	3000	14000
C		
node 1	5500	13000
node 2	7000	14000
D		
node 1	5500	10500
node 2	5500	11000
node 3	6500	11500
node 4	7500	11000
node 5	8000	10500
node 6	7500	10000
node 7	7000	9500
node 8	6500	9500
node 9	6500	10000
node 10	6000	10500
node 11	5500	10500
E		
node 1	2000	11000
node 2	2500	11500
node 3	3000	11000
node 4	3000	10500
node 5	2500	10000

Figure 3. Example Vector Map Exercise



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Questions:

Which data type do you think requires more computer storage memory and processing time, vector or raster? Why?

Vector, because each shape has to be individually processed compared with a raster model where the majority of info is interpolated from a smaller number of specific data points

Which spatial data type is also used in digital image files that are found on the internet (like *.tif, or *.jpg). points (pixels) in a raster file

Compare feature D to feature E in terms of data structure. What is the primary difference between the two feature types?

E is not a polygon because it does not close upon itself. D is not a polyline because nodes I and II are in the exact same location.

Using a red colored pencil (or any other color of your choosing), convert vector map elements A through E to "Raster map elements". Using the grid network shown on Figure 3, color in the raster version of each of the elements (hint: refer to Figure 2A for some ideas).

Task B-3. Refer to the Monmouth Quadrangle paper maps available in the class room. Identify the following map elements by the vector method that would best represent them in digital map space (point, line, polyline, polygon):

Map Element	Vector Method
Highways / Roads	polyline
City Limits	line
Contours	polyline
Small Creeks	polyline
Major Rivers	polygon
School Buildings	polygon
WOU Property Boundary	line
Benchmarks	point
County Outlines	polyline
County Boundaries	polyline
Sewage Ponds	polygon
Fire Hydrants	point
Lamp Posts	point

Now visit the Monmouth Quad. Geologic Map available on the west wall in RM 218 of NSB. Try the same game:

Map Element	Vector Method
Faults	polyline
Map unit Qal	polygon
Map unit Tss	polygon

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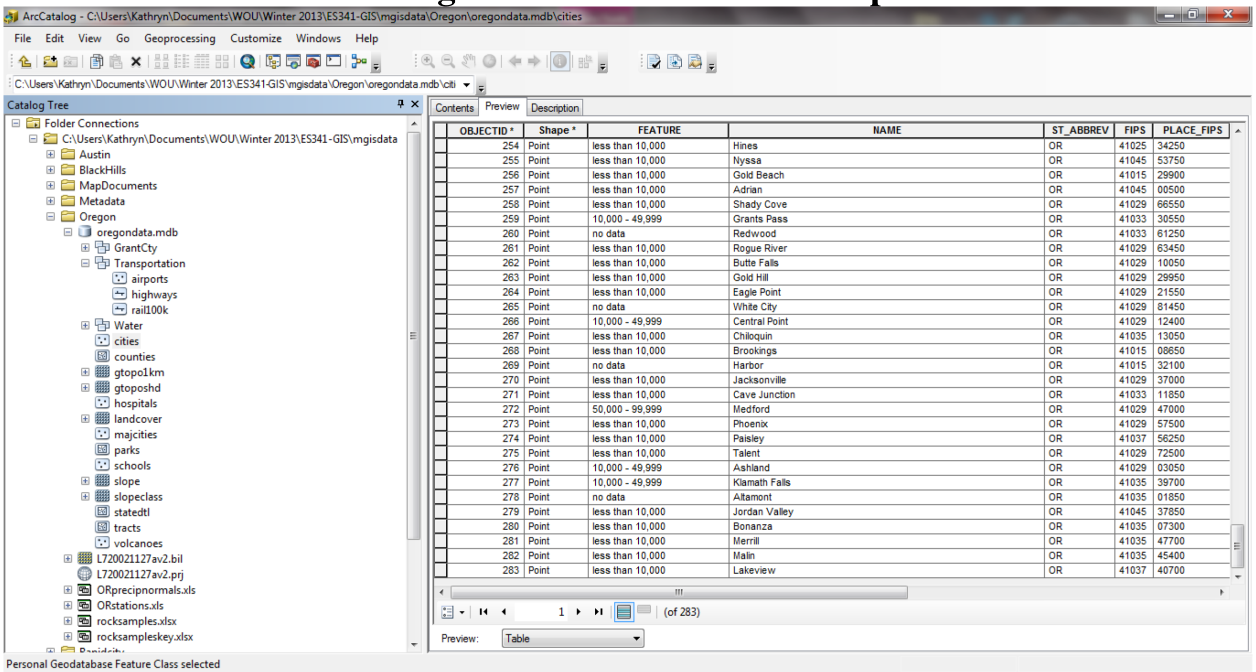
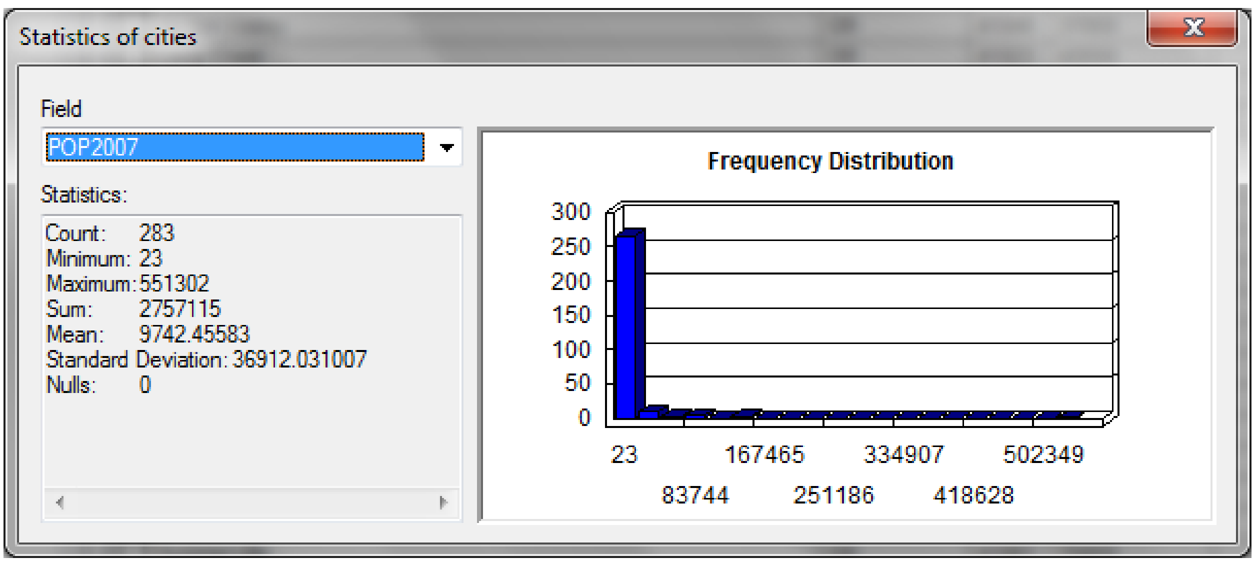
Mastering Skills Screen Shots – Chapter 1



ArcCatalog – Folder Connections added, previewing files using ArcCatalog, pg. 25-28



ArcCatalog – Frequency diagram from Statistics option of table field data, pg. 29

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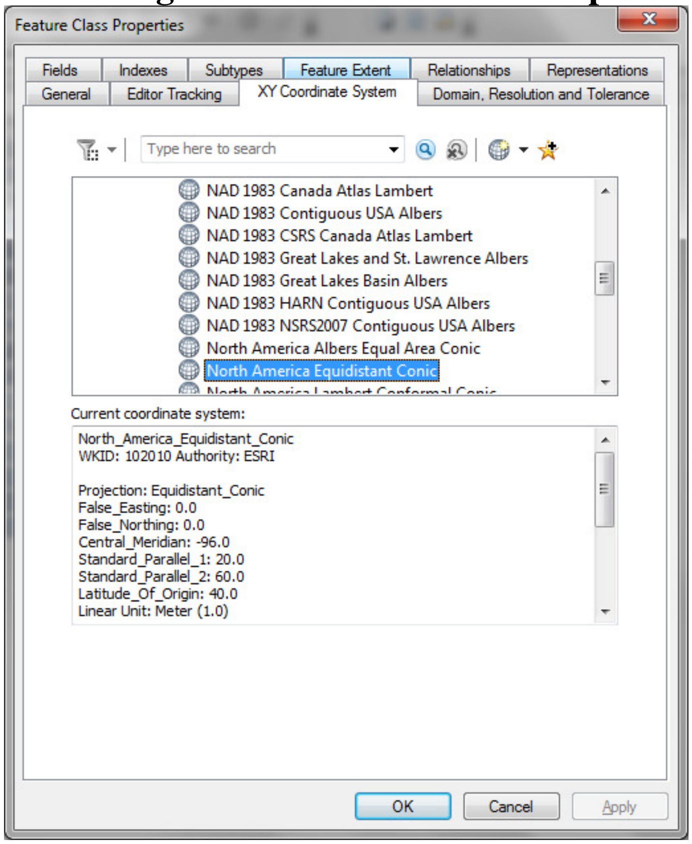
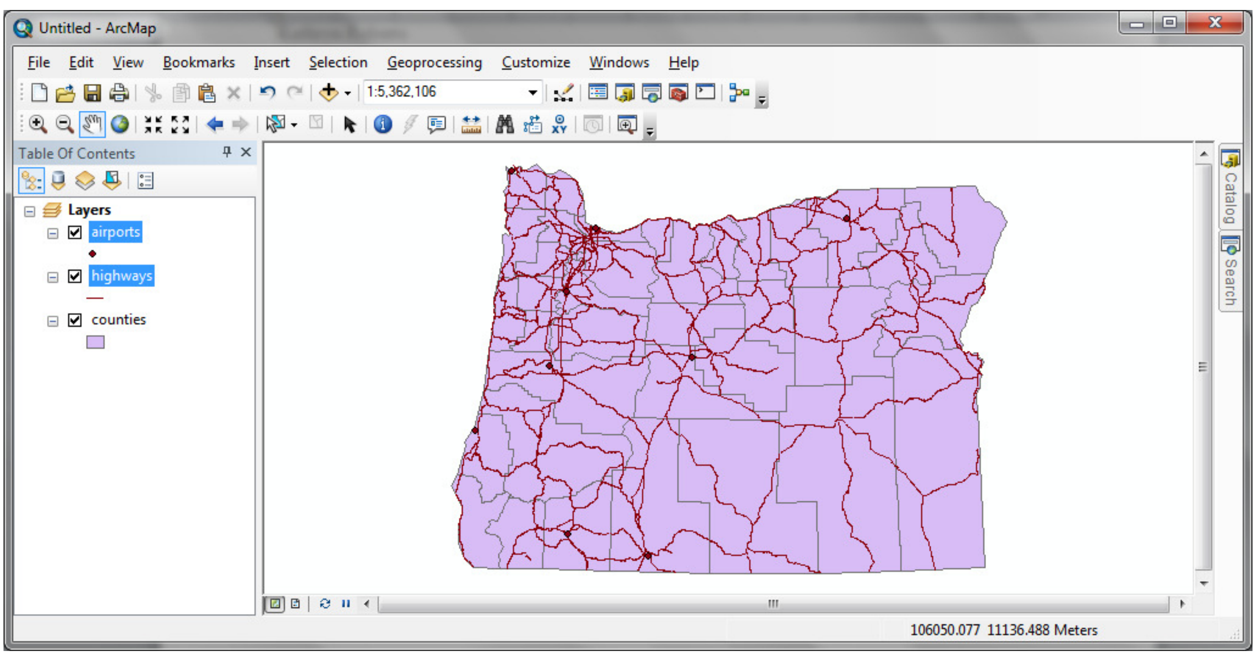
Mastering Skills Screen Shots – Chapter 1



ArcCatalog – Viewing the Feature Class Properties menu, pg. 30



ArcMap – Adding Data from connected folders to ArcMap, pg. 31

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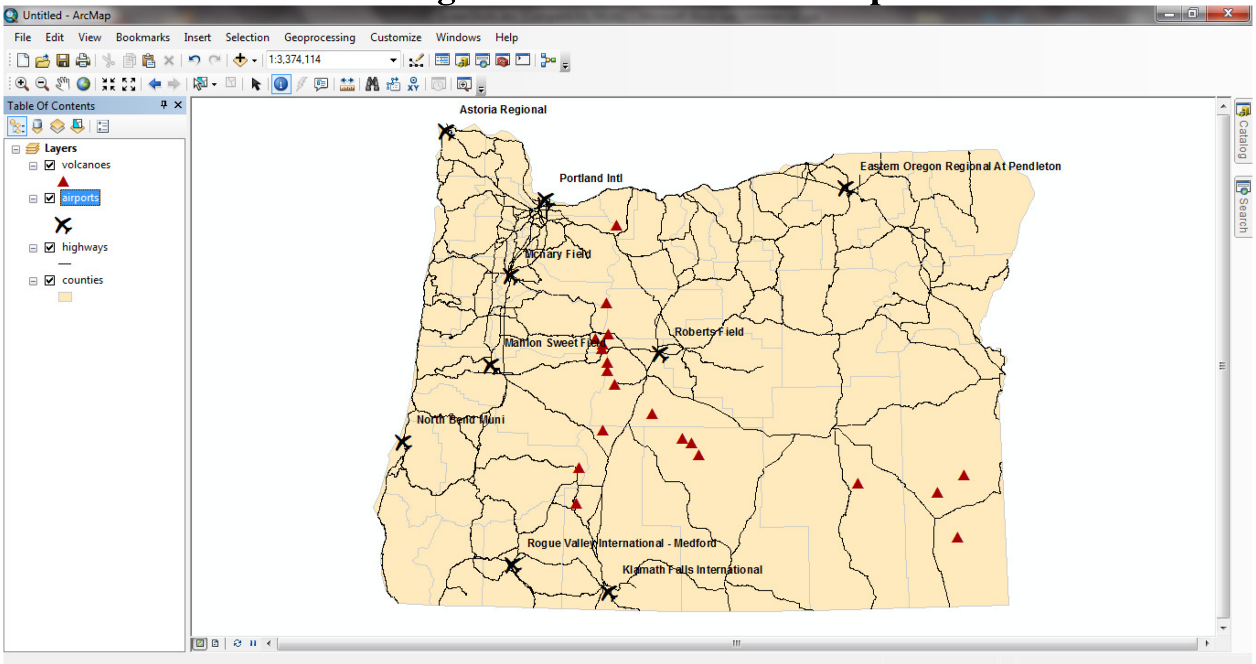
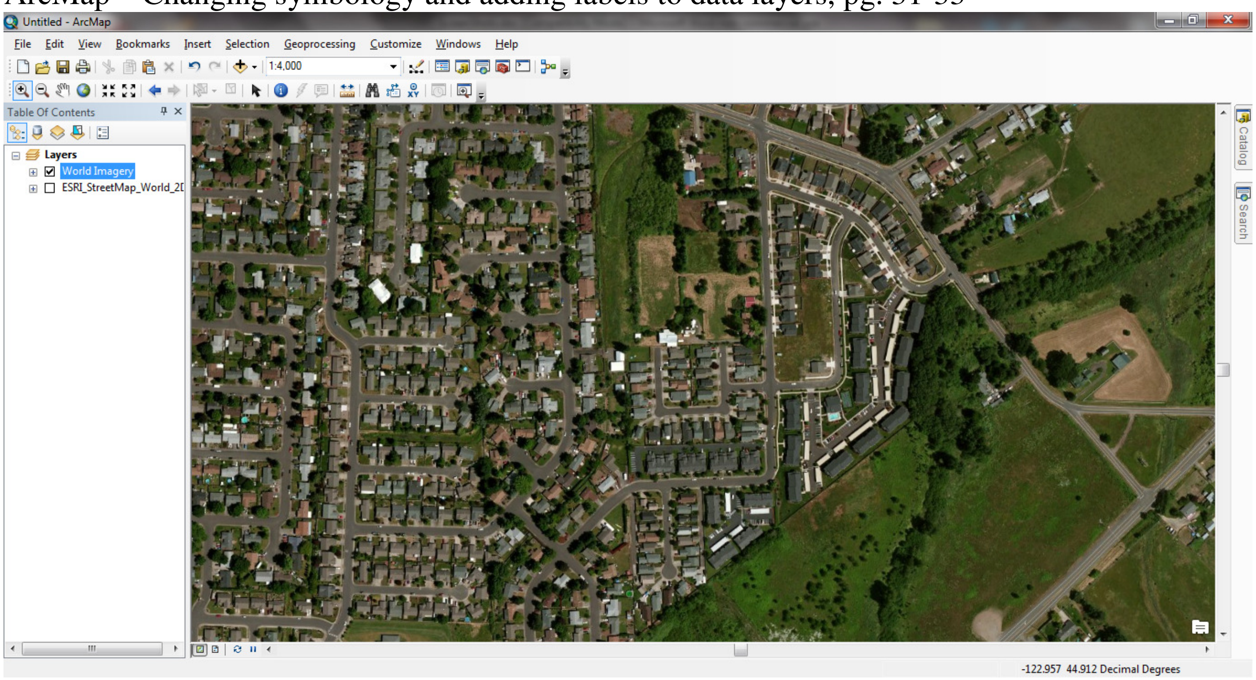
Mastering Skills Screen Shots – Chapter 1



ArcMap – Changing symbology and adding labels to data layers, pg. 31-33



ArcMap – Finding my neighborhood using ArcGIS Online World_Imagery, pg. 34-39

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Mastering ArcGIS Chapter 1 Tutorial Short Answers

Pg. 27:

1. How many coverages are there in the archive folder? 2. How many tables? 1. How many rasters? 1. How many layers? 1. How many shape files? 7.

Pg. 28:

2. What is the name of the county in the northeast corner of Oregon? Wallowa.

Pg. 29:

3. How many records are there in the table? 283.
4. Which city has the smallest 2007 population? Granite.

Pg. 30:

5. List the projection: Equidistant_Conic and the linear unit: meter

Pg. 35:

6. What is the name of the field that is being displayed in the Map Tips? NAME.

Pg. 37:

7. What is the name of the coordinate system? NAD_1983_Oregon_Statewide_Lambert. What is the linear unit? Meter.

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Chapter 1 Review Questions (1, 2, 3, 6)

1. Explain the difference between the terms feature, feature class, and feature dataset.
    a. Feature – vector objects (points, lines, or polygons) used in GIS maps
    b. Feature Class – like features that are grouped into data sets
    c. Feature Dataset – grouping of multiple feature classes that are related
2. Imagine you are looking at a geodatabase that contains 50 states, 500 cities, and 100 rivers. How many features classes are there? How many features? How many attribute tables? How many total records in all the attribute tables?
    a. There would be 3 feature classes (states, cities, and rivers).
    b. There would be a total of 650 features.
    c. There would be 3 attribute tables (one for each of the feature classes).
    d. There would be a total of 650 records in all attribute tables (1 for each feature).
3. If each of the following data were stored as rasters, state which ones would be discrete and which ones would be continuous: rainfall, soil type, voting districts, temperature, slope, and vegetation type.
    a. Discrete: soil type, voting districts, vegetation type
    b. Continuous: rainfall, temperature, slope

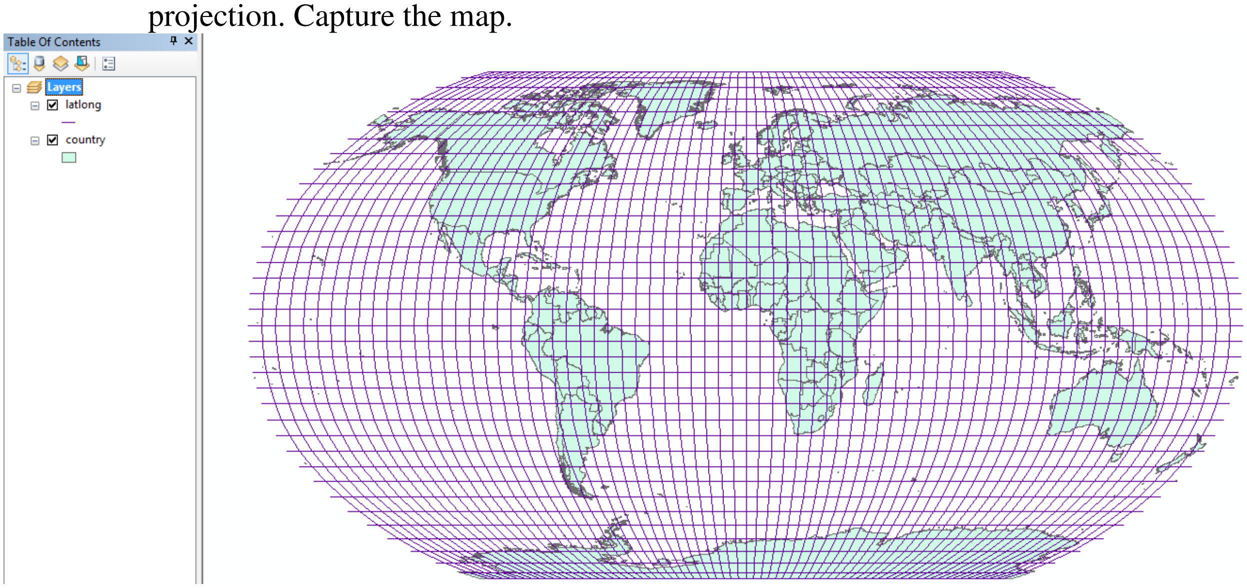
6. You measure a football field (100 yards) on a detailed map and find that it is 0.5 inches long. What is the scale of the map?

0.5 in = 100 yards
1 yard = 3 feet
100 yards = 300 feet
0.5 in = 300 feet
300 feet x 12(in/ft) = 3600 in
0.5 in = 3600 in.
1: 7200

Chapter 1 Exercises (1-6, 10)

1. How many feature datasets are there in the oregondata geodatabase in the mgisdata/Oregon folder? List their names. How many total feature classes does the geodatabase have? How many rasters?
    a. Three feature datasets (GrantCty, Transportation, and Water)
    b. Nine feature classes
    c. Five rasters
2. What is the coordinate system of the country shapefile in the mgis/World folder? Of the parks feature class in the oregondata geodatabase?
    a. GCS_WGS_1984
    b. NAD_1983_Oregon_Statewide_Lambert
3. What type of information does the feature class cd111 in the usdata contain? On what date was the information current? Is it current now?
    a. Congressional districts in the US
    b. Information was current for February 25, 2009
    c. It is not current now, Congressional districts were re-drawn after the 2010 census
4. Which is the largest lake in the United States? What is its area?
    a. Lake Superior is the largest lake
    b. 78739809369.912857 meters'
5. Which state has a county named Itawamba?
    a. Mississippi
6. What is the minimum, maximum, and average 2007 population density of census tracts in the city of Austin, TX?
    a. Minimum = 494
    b. Maximum = 34404
    c. Average = 6522.940594

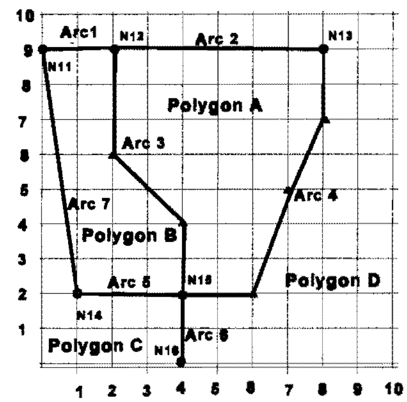
10. Change the data frame coordinate system to view the layers in the Word Robinson projection. Capture the map.



Kathryn Roberts
01/14/13

In Class Exercise - Geometric Elements and Topology

The Figure at the right is a polygon map theme with polygons A, B, C, and D. The polygons are constructed from arcs 1 through 7. The arcs are composed of Nodes N 11 through N 14. The topology of the map is built upon graphical analysis of the georeference coordinates of the nodes and the arcs/polygons that they build.



The table below shows a typical topological framework for the spatial relations. The abbreviations are as follows:

Fnode The node at the beginning or start of an arc, "From Node"
Tnode The node at the end of an arc, "To Node"
Arc# The internal number assigned to identify the arc
Lpoly Attributes of the Left Polygon while "driving" from the Fnode to Tnode, along the arc.
Rpoly Attributes of the Right Polygon while "driving from the Fnode to Tnode, along the arc.

Exercise to complete. Based on the answer model for the first row below, complete the topological tables for the map to the right.

Arc Node List (clockwise)

Arc#	Fnode	Tnode
1	11	12
2	12	13
3	12	15
4	13	15
5	15	14
6	15	16
7	14	11

Arc Coordinate List

Arc#	x,y Coordinates
1	(0,9) (2,9)
2	(2,9) (8,9)
3	(2,9) (4,2)
4	(8,9) (4,2)
5	(4,2) (1,2)
6	(4,2) (4,0)
7	(1,2) (0,9)

Arc Polygon List

Arc#	Lpoly	Rpoly
1	Polygon D	Polygon B
2	Polygon D	Polygon A
3	Polygon B	Polygon A
4	Polygon A	Polygon D
5	Polygon B	Polygon C
6	Polygon C	Polygon D
7	Polygon C	Polygon B

D. Topological Errors
1. topological errors arise when nodes and arcs are not properly "snapped" to one another or aligned
2. Error Types
   a. dangling nodes - nodes dangle in space without being snapped to another node
   b. undershoots - nodes are short of being snapped
   c. overshoots - nodes are long on being snapped
   d. leaky polygons - polygons are not closed, nodes are not properly snapped

See diagram below for examples

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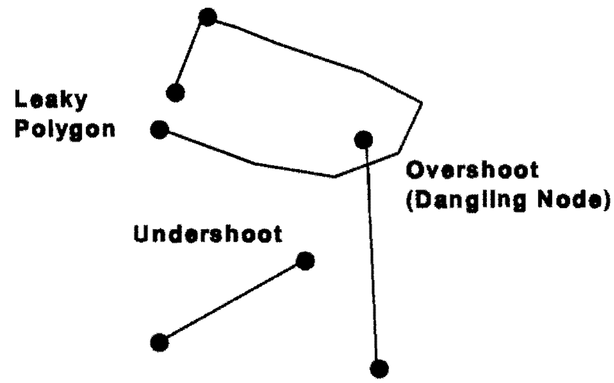

IV. Map Scale, Spatial Resolution, and Spatial Data Accuracy

A. Map scale is an indicator of map accuracy
   1. The smaller the scale, in general, the lesser the accuracy, and vice versa
      a. e.g. map accuracy at 1:100,000 scale is much less than 1:24,000 scale

B. Locations Accuracy and Topological Accuracy in GIS
   1. Location Accuracy - measures the error in the absolute position of a map point or feature relative to real world, georeference coordinates.
   2. Topological Accuracy - a measure of the error in topology and attribute features of map features

C. USGS Map Standards for Accuracy
   1. USGS maps are tested and standardized so that there is no more than 10% of total position points can be more than 0.02 inches (0.5 mm) out of position at the prevailing map scale.

In Class Exercise

At a scale of 1:65,000, 0.02 inches on the map represents how much distance on the ground in meters? Show all of your work.

$0.02 \times 65{,}000 = 1300 \text{ in} \left(\frac{2.54 \text{ cm}}{1 \text{ in}}\right)\left(\frac{\text{m}}{100 \text{ cm}}\right) = \boxed{33.02 \text{ m}}$

Given a scale of 1:24,000, 30 m error on the ground would represent how many millimeters of error on the map? Show all of your work.

$\frac{30}{24{,}000} = .00125 \text{ m}\left(\frac{1000 \text{ mm}}{\text{m}}\right) = \boxed{1.25 \text{ mm}}$

Given a scale of 1:24,000 and a spatial feature resolution of 10 m, how many inches of resolution does this represent in map units? Show all of your work.

$\frac{10 \text{ m}}{24000} = 4.16 \times 10^{-4} \text{ m} \left(\frac{3.28 \text{ ft}}{1 \text{ m}}\right)\left(\frac{12 \text{ in}}{\text{ft}}\right) = \boxed{.0164 \text{ in}}$

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ES341 Introduction to Georeferencing, Map Layers and Spatial Associations

One of the basic principles of GIS is the notion of map layers (thematic layers of information; points, lines or polygons) that are georegistered in a common coordinate space. Georeferencing allows layers to be placed in a unified geographic coordinate system, so that map elements (e.g. bedrock geology polygons) and related attribute information (e.g. rock type, lithology, age) are properly aligned and overlie one another in spatial context. Georeferencing and thematic layers provide a power framework to conduct spatial analyses within and between coverages; useful for such activities as city planning, zoning, hazards mitigation, etc.

This exercise provides a hands-on introduction to georerencing, projected 2-D coordinate systems and layered map themes. Attached are four analog map-layer transparacencies for the Monmouth-Independence area (attached handouts). The four layers include (1) Monmouth-WOU Roads, (2) WOU Buildings, (3) Monmouth Geology, and (4) Monmouth Flood Hazard Zonation. The following is the key for the geology and flood polygon identifiers:

Geology Code

ID	Explanation
Qtlb	Quaternary Alluvium (bottomlands)
Qtm	Quaternary Alluvium (middle terrace)
Qth	Quaternary Alluvium (high terrace)
Ts	Eocene Spencer Formation

Flood Hazards Code

ID	Explanation
NO	Not in flood plain
FL	Part of zone AE – Floodway (active annually)
A	100 year flood
AE	100 year flood with elevation determined
X	500 year flood

The projected map referencing system for all four layers is Oregon State Plane North in feet **(NOTE: THE TRANSPARENCIES HAVE SCALE LISTED UNITS IN "METERS", THIS IS A TYPO, THE BAR SCALE IS IN FEET).** The neatline box is set at the same dimensions and scale in each of the four map layers. Examine the maps / transparencies, complete the following tasks.

1. Determine the fractional scale of the Monmouth map layers. Show all of your math work.

   $.\overline{66}$ in = 1000 ft   1000 ft $\left(\frac{12 \text{ in}}{\text{ft}}\right)$ = 12,000 in $\frac{.\overline{66} \text{ in}}{.\overline{66} \text{ in}} = \frac{12{,}000 \text{ in}}{.\overline{66} \text{ in}}$ = **1:18,000**

2. The upper left corner of the neat box is located at the following State Plane Coordinate

Easting: 7,488,836 ft Northing: 449,324 ft

a. Using map scale, engineers scale and ruler, determine the following state plane coordinates for the other 3 corners of the neat box. Show all of your math work.

	Easting (ft)	Northing (ft)
Upper Right (NE) Corner	7498361	449,324
Lower Right (SE) Corner	7,498,361	438,224
Lower Left (SW) Corner	7,488,836	438,224

Northing - 7.4 in × 18,000 (ft/12 in) = 11,100

Easting — 6.35 in × 18,000 (ft/12 in) = 9,525

b. Calculate the total area of the map coverage, as defined by the bounding rectangular neatline, in square feet. Show all of your math work.

9,525 ft × 11,100 ft = 105727500 ft²

c. Calculate the total area of the map coverage, as defined by the bounding rectangular neatline, in square kilometers. Show all of your math work.

$105{,}727{,}500\ ft^2 \left(\frac{m}{3.28\ ft}\right)^2 \left(\frac{km}{1000 m}\right)^2 = 9.827\ km^2$

d. Calculate the total area of the map coverage, as defined by the bounding rectangular neatline, in hectares. Show all of your math work.

$9.827\ km^2 \left(\frac{100\ H}{km^2}\right) = 982.7\ Ha$

3. Overlay and align (georegister) the Monmouth Roads layer (transparency) on top of the WOU Buildings layer (transparency). Using the red transparency marker, draw a rectangular box on the Roads layer that circumscribes the footprint distribution of the WOU Buildings layer below. Label the box you've drawn "WOU Boundary".

   a. Calculate the area of the rectangular box / building footprint you've drawn in square feet. Show all math work and conversions.

   1.6 in × 18,000 (ft/12 in) = 2400 ft 2400 ft × 3000 ft = 7200000 ft²
   2 in × 18,000 (ft/12 in) = 3000 ft

   b. Calculate the area of the rectangular box / WOU boundary polygon you've drawn in square kilometers. Show all math work and conversions.

   $7{,}200{,}000\ ft^2 \left(\frac{m}{3.28\ ft}\right)^2 \left(\frac{km}{1000 m}\right)^2 = .67\ km^2$

   c. Calculate the area of the rectangular box / WOU boundary polygon in hectares. Show all math work and conversions.

   $.67\ km^2 \left(\frac{100\ H}{km^2}\right) = 66.9\ Ha$

4. Overlay and align (georegister) the WOU buildings layer on top of the Monmouth Roads layer. Using your mental geography of Monmouth and the Monmouth 7.5-min quad, identify Main Street and Monmouth Ave. on the Roads Layer. Now using the blue transparency marker, trace/draw both streets onto the WOU Buildings layer, from end to end as shown on the map extent.

5. Identify, outline and label the Natural Science Building on the WOU layer (transparency). Identify, outline and label the "New PE" Building on the north side of the stadium.

   a. Measure the center-to-center distance between the Natural Science Building and New PE in feet.
      .9 in × 18,000 (ft / 12 in) = 1350 ft.

   b. Measure the center-to-center distance between the two buildings in kilometers, show all of your math work.
      1350 ft (m / 3.284)(Km / 1000 m) = .4115 km

6. Overlay and align (georegister) the Monmouth-WOU Geology layer on top of the Monmouth Flood Zones layer (transparency). Outline all of the "no flood zones" polygons (map unit "NO") on the geology overlay using a blue marker pen.

7. Overlay and align (georegister) the Monmouth-WOU Geology layer on top of the Monmouth Flood Zones layer (transparency). Group the FL (floodway), A-AE (100 yr floodplain), and X (500 yr floodplain) hazards units, and outline them with the red marker pen on the geology overlay.

8. Overlay and align (georegister) the Flood Hazard layer on top of the WOU Buildings layer. On the flood hazard overlay, use a compass and ruler to draw a circle 2000 feet in diameter, with center located in the middle of the Natural sciences building.

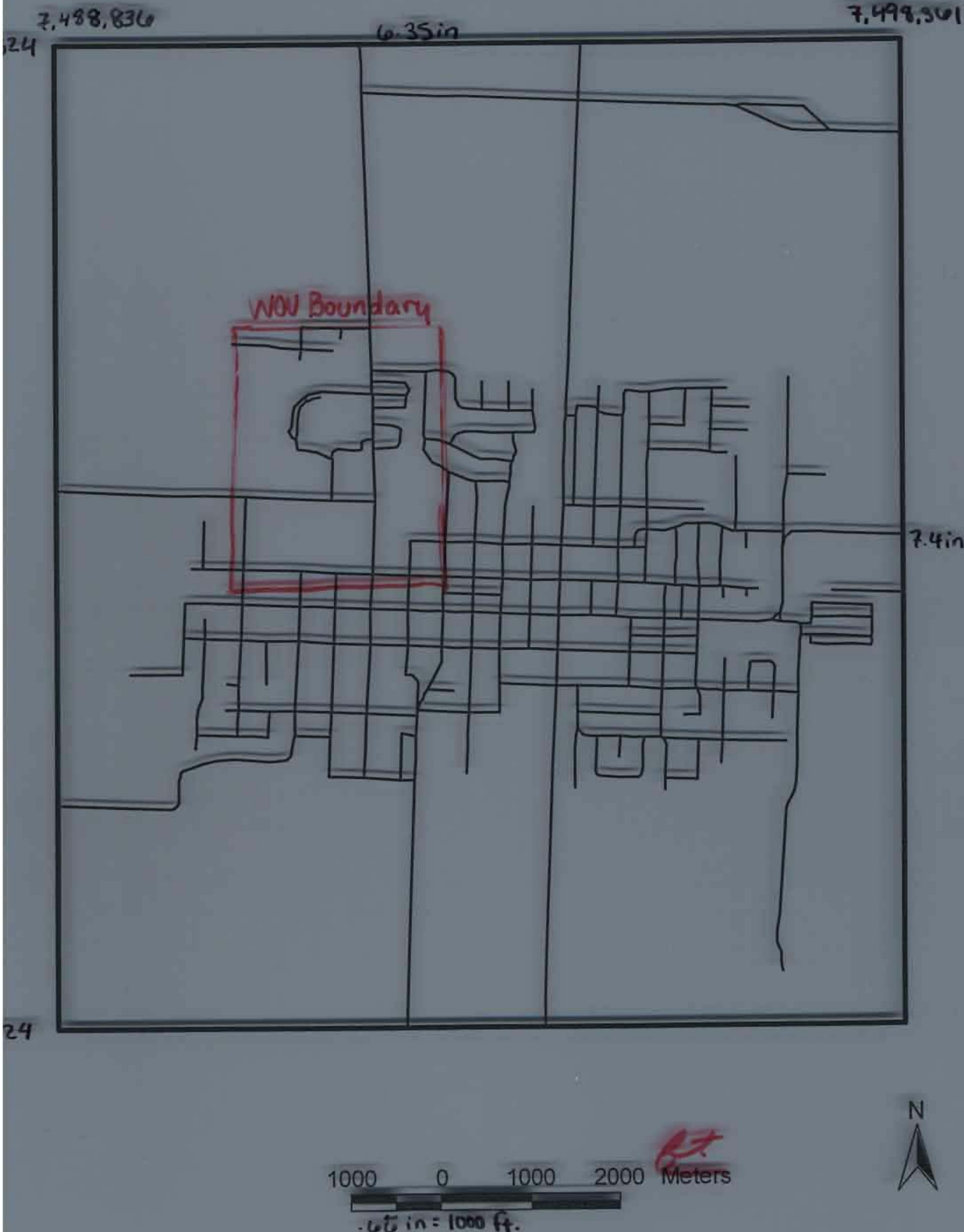
9. Answer the following questions:
   a. Which geologic map units are associated with flood hazards in the Monmouth area? Explain your answer in terms of geologic map associations with flood hazards.
      Qtlb - the lowest river terrace is the closest associated with flood hazards, as it is the most recent rock unit to be an active flood plain
   b. Which geologic map units are associated with unit "NO" no flood hazards in the Monmouth area? Explain your answer, what geologic reasons are associated with an "NO" hazard designation.
      Qtm, Qth which are older flood plains and are thus further from the active flood plain
   c. What is the probability of the Natural Sciences building being flooded by the Willamette River in the next 100 years? In the next 500 years? Explain your answer and line of reasoning.
      The probability is very low as the entire WOU Campus is within the No flood (Qtm/Qth) area.

10. Using the Monmouth Geology layer and your calculated map area from 2b above, determine the percentage of the map area covered by Quaternary Alluvium (Qtlb+Qtm+Qth) vs. Eocene Spencer Formation (Ts)

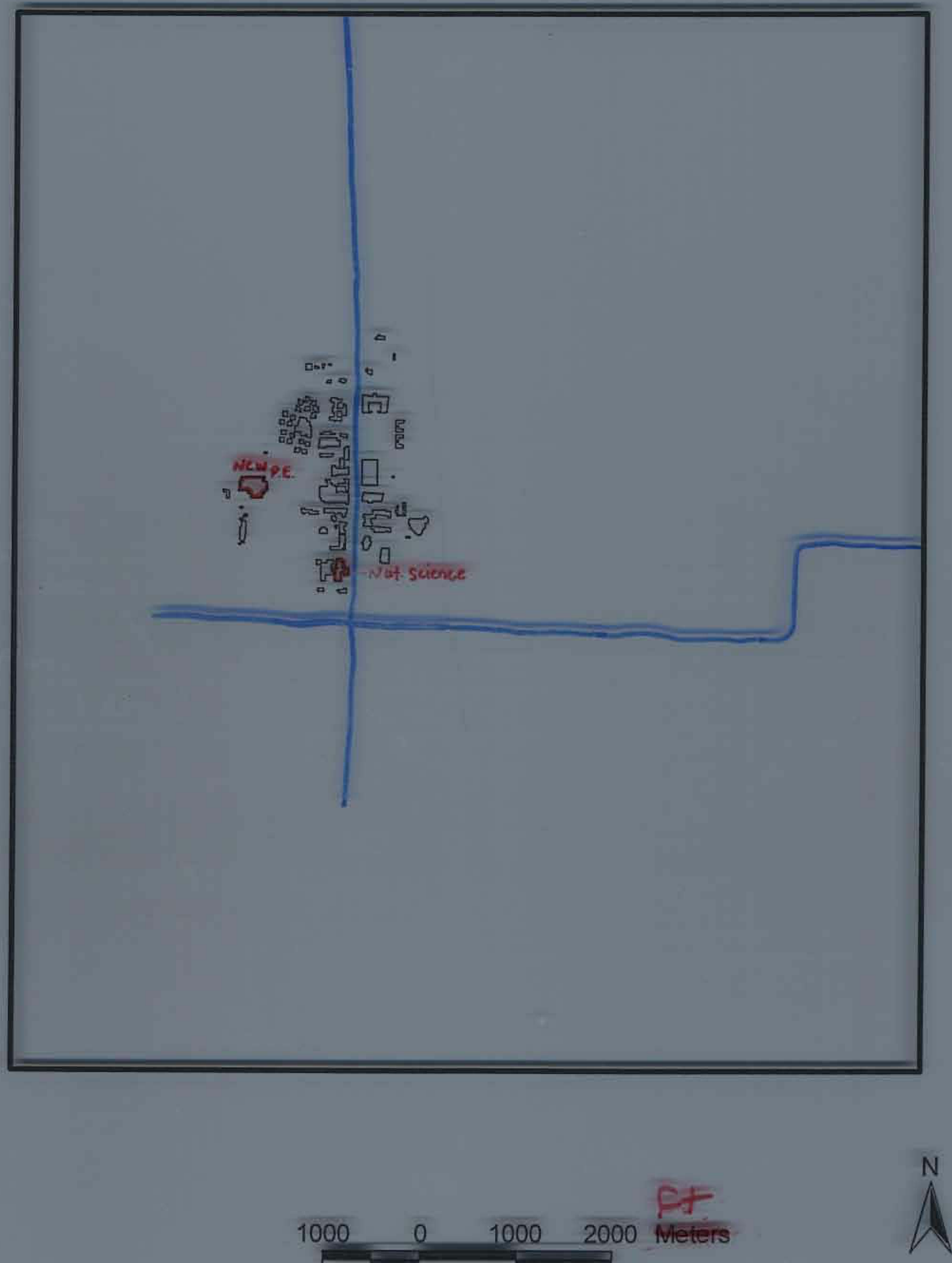
a. Total Map Area	105,727,500	sq. ft	100	% of Total
b. Total Qa Area	101 407 500	sq. ft	95.9	% of Total
c. Total Ts Area	4 320 000	sq. ft	4.1	% of Total

11. Given your calculated areas and percentages in 10 above, hypothesize as to the potential for the occurrence of alluvial water-bearing aquifers in the WOU-Monmouth area. Explain your answer and line of reasoning.
The WOU-monmouth area would likely not be a good region for aquifers as the majority of the geology is Quaternary Alluvium, and only a small portion (~4%) is bedrock with sufficient aquiclude layers (like shale) to trap water and form an aquifer.

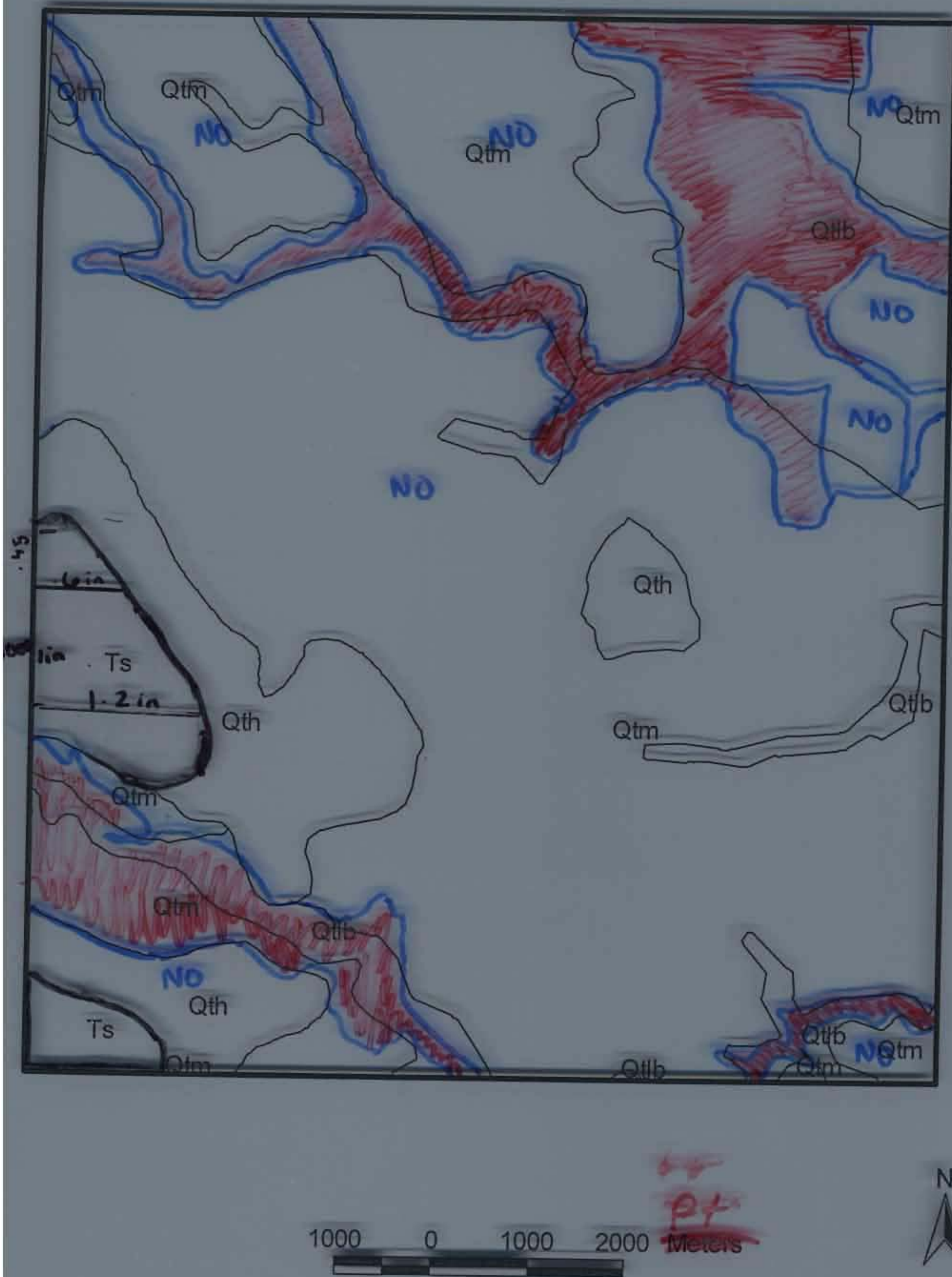
Monmouth-WOU Roads



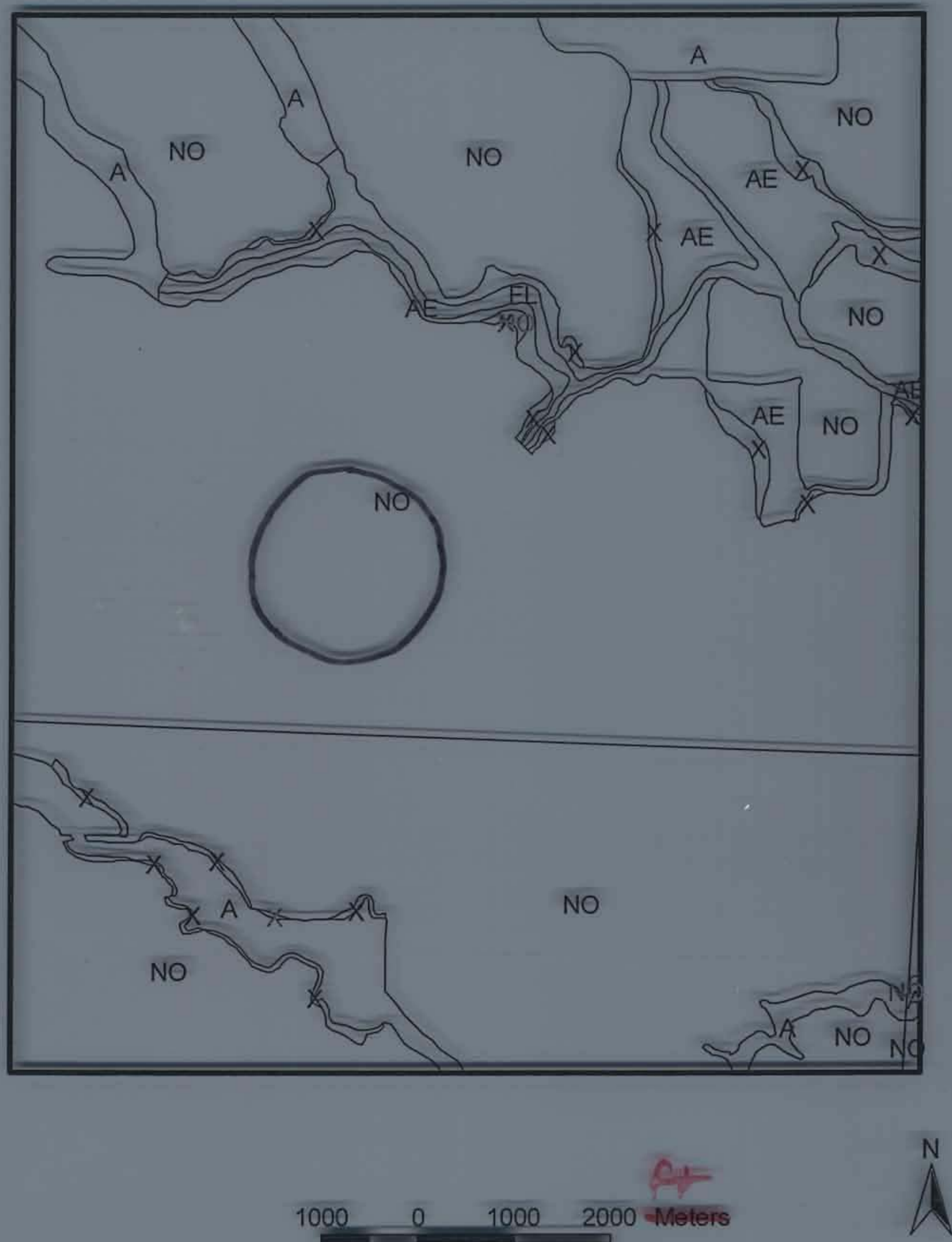
WOU Bldgs



Monmouth-WOU Geology



Monmouth Flood Zones



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B. Map Resolution - ability to resolve surface features on a map, depends on scale

Example of Map Resolutions Based on Line Width of 0.5 mm

Line Width (0.5 mm)	Scale	Resolution	Smallest Detectable Object	Area (sq. m) (Minimum)
0.5	1:24,000	12 m	24 m	576
0.5	1:50,000	25 m	50 m	2500
0.5	1:250,000	125 m	250 m	62,500
0.5	1:5,000,000	2500m	5000 m	25,000,000

In-Class Exercise: Spatial Scales and Digital Image Resolution

In remote sensing, a given "scene" is a particular portion of the Earth's surface that is captured in and aerial photograph or satellite image. The digital resolution of the "scene" is the amount of land area that is covered in 1 pixel of the image. Each pixel is assigned a digital color code or shade. When all pixels are combined together a resultant digital image is produced. The resulting image is arranged in a series of columns and rows of pixel boxes.

Problems:

(1) Given a scale of 1:48,000 on a topographic map, a square plot of land covers 8 inches by 8 inches in map units.

Determine side distances of the plot in meters. 8 in × 48,000 = 384,000" $\left(\frac{2.54\,cm}{in}\right)\left(\frac{m}{100\,cm}\right)$ = 9753.6 m

Determine the area of the plot is square kilometers. 9753.6 m × 9753.6 m = 95132712.96 m² $\left(\frac{km}{1000\,m}\right)^2$ = 95.13 km²

(2) Determine the number of rows and columns in an image of the plot with the following spatial resolutions:

	No. Rows	No. Columns
1 - meter resolution	9754	9754
10-meter resolution	976	976
30-meter resolution	326	326
100-meter resolution	98	98

(3) If you had an image of the plot that was comprised of 2500 rows and columns, what is the resulting spatial resolution?

$\frac{2500\text{ rows}}{2500} = \frac{9753.6\,m}{2500}$

1 row = 3.9 m

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In-Class Exercise - Measuring Great Circle Distances on the Globe

Definition of Great Circle - a line passing between any two points on the globe, which can form an angle with the vertex at the center of the Earth (e.g. all meridians are great circles, the only parallel that is a great circle in the 0 degree lat parallel, or equator)
Equation for Great Circle Distance on a Sphere Between any Two Points, A and B on a sphere:

$$\cos(D) = (\sin(a)*\sin(b)) + (\cos(a)*\cos(b)*\cos|\gamma|)$$

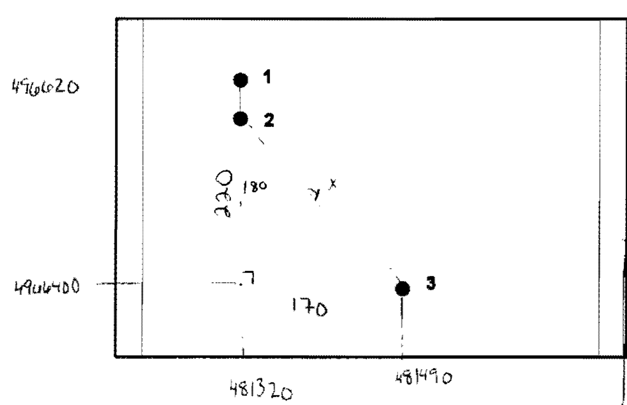
where D = angular distance in degrees between two points (1 degree on great circle = 69 miles), a and b are the geographic latitudes of points A and B, $|\gamma|$ = the absolute value of the difference in longitude between pts. A and B
Problem: determine the great circle distance in miles between Nome, AK and Miama, Fla. using the following positions.

A Nome lat = 63° 30' N (63.5°) long = 165° 20' W (165.33)
B Miami lat = 25° 45' N (25.75) long = 80° 11' W (80.183)
37.75 85.150
hint: you must convert your lat and long to decimal degrees

(sin(63.5)·sin(25.75)) + (cos(63.5)·cos(25.75)·
cos(85.150) = .4227 = cos(D)
64.989° = D
× 69
4484.3 miles

Part 2 - Examine the map figure below with pt. locations 1, 2, and 3. The points are located at the following UTM coordinates

	Easting (m)	Northing (m)
pt. 1	481320	4966620
pt. 2	481320	4966580
pt. 3	481490	4966400



1-3
$x^2 = 170^2 + 220^2$
$x^2 = 77300$
$x = 278.03$

2-3
$y^2 = 170^2 + 180^2$
$y^2 = 61300$
$y = 247.6$

Use Pythagorean's theorem to determine the distances between the following point combinations (SHOW all of your math work!):

Distance 1-2 (meters) = 40 m
Distance 1-3 (meters)= 278.03 m
Distance 2-3 (meters)= 247.6m
Distance 3-3 (meters)= 0 m
