Name: KEY

GIS in Water Resources Midterm Exam **Fall 2011**

There are 4 questions on this exam. Please do all 4.

1. Location on the Earth

(a) Brownsville, Texas is located at (25° 55' 9"N, 97° 29' 25"W). If a line is drawn directly North from Brownsville, it will leave the United States at the 49th parallel, in northern North Dakota. Calculate the length of this line in km assuming a spherical earth with a radius of 6378 km.

LATITUDE DIFFERENCE

$\Delta\phi = 49 - 25 + \frac{55}{60} + \frac{9}{3600}$

$= 49 - 25.9192$

$= 23.0808°$

$\therefore$ LENGTH $= \frac{23.0808}{180} \times \pi \times 6378$

$= 2569.3$ km [8]

(b) Define the term Longitude and use a diagram to illustrate your definition.

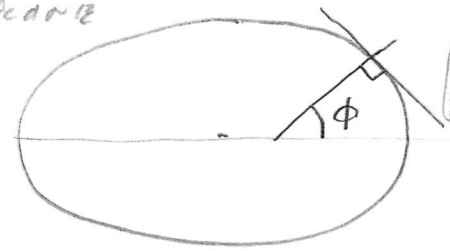
LONGITUDE IS THE ANGLE EAST OR WEST OF THE GREENWICH (PRIME) MERIDIAN, THE LINE FROM POLE TO POLE THROUGH GREENWICH.

VIEW FROM ABOVE NORTH POLE

[6]

(c) Define the term Latitude and use a diagram to illustrate your definition.

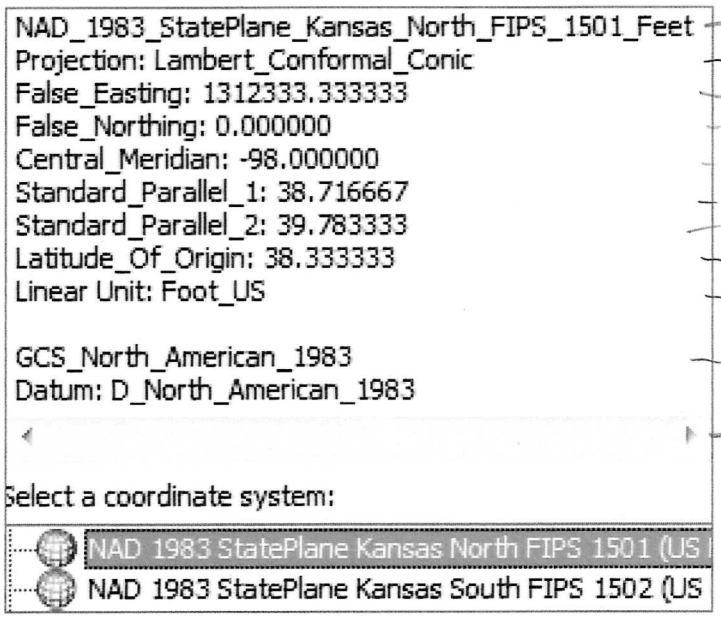
LATITUDE IS THE ANGLE OF A LINE PERPENDICULAR TO THE SPHEROID SURFACE WITH THE PLANE THROUGH THE EQUATOR.



[6]

2. ArcGIS as a Geographic Information System

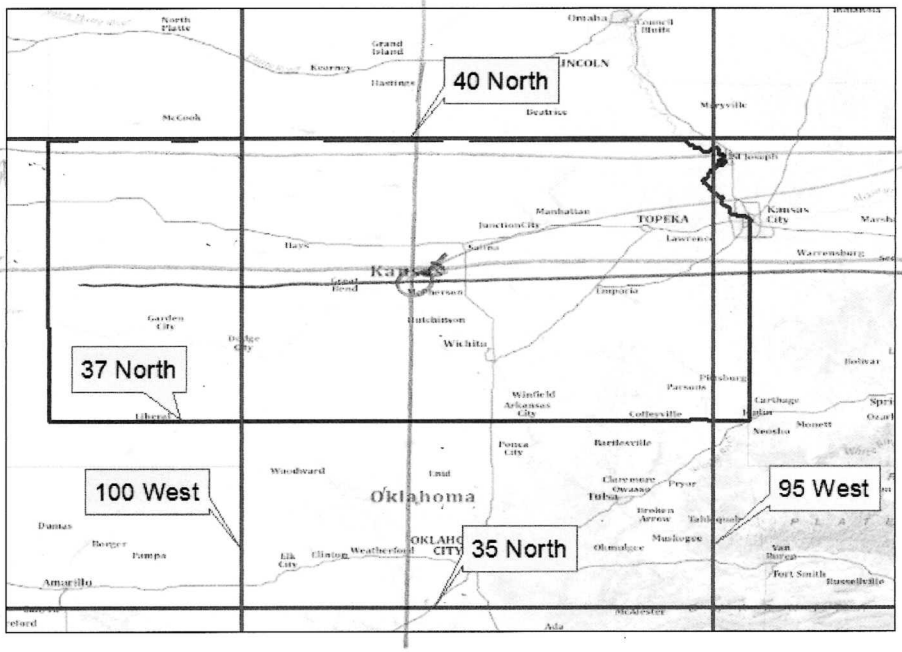
Here are the parameters of one of the zones of the Kansas State Plane Coordinate System. Beside each line in the table below, briefly explain what it means.



PROJECTION NAME
PROJECTION TYPE
X COORDINATE OFFSET
Y COORDINATE OFFSET
LONGITUDE OF ORIGIN (λ_o)
LATITUDES WHERE PROJECTION CONE INTERSECTS SPHEROID
LATITUDE OF ORIGIN (ϕ_o)
UNITS FOR DISTANCE
NAME OF UNDERLYING GEOGRAPHIC SPATIAL REFERENCE
HORIZONTAL DATUM SPECIFYING SPHEROID USED FOR LAT & LONG.

[9]

Draw the lines representing (ϕo, λo) on the map below and label their intersection with the numerical values of (Xo, Yo) in the projected coordinate system. Also, draw the standard parallels on the map. What happens along the standard parallels?



39.78
38.72
STD PARALLELS

(1312333, 0)

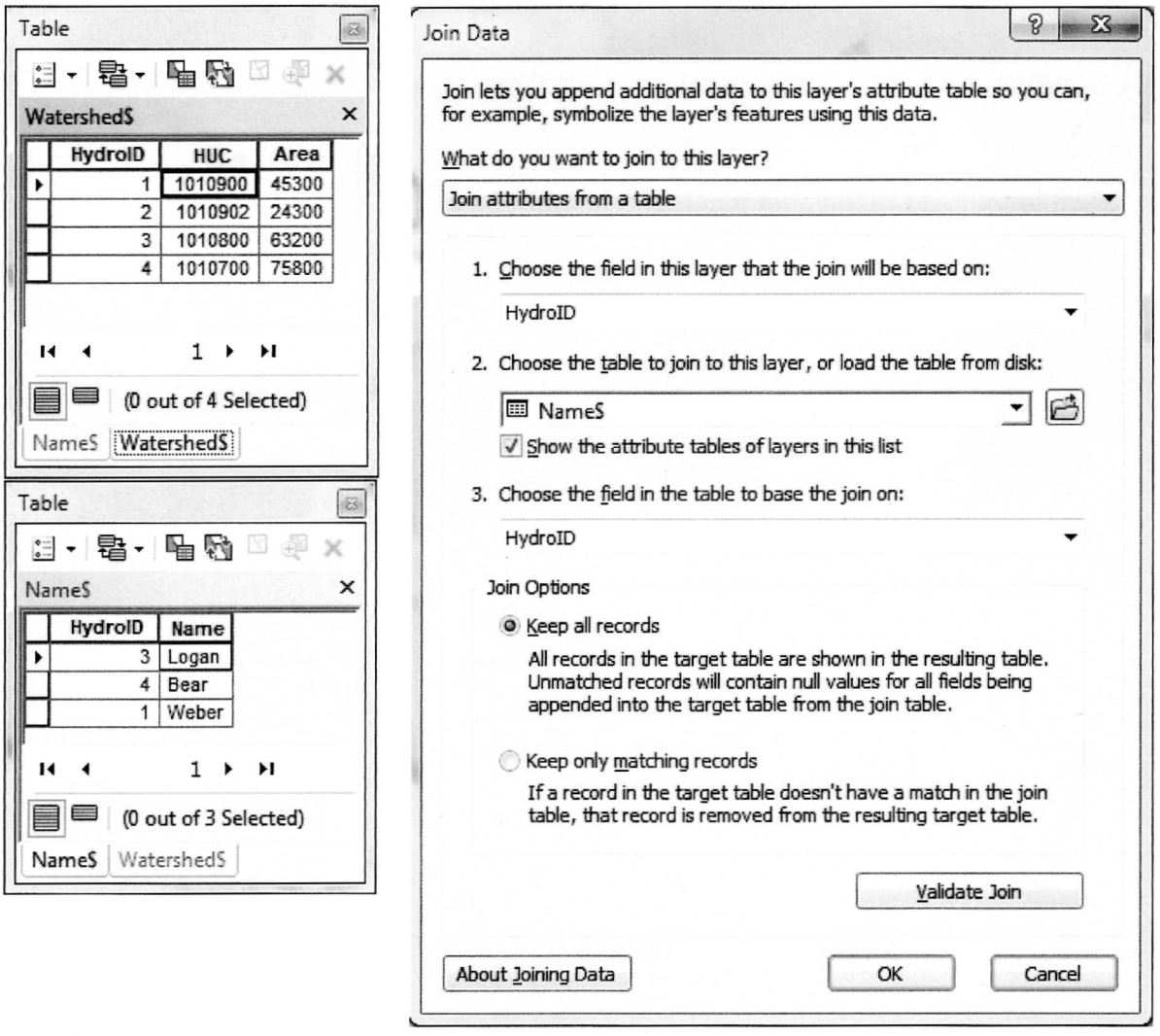
$\phi_o = 38.33$

LENGTH IS PRESERVED ALONG THE STD PARALLELS.

$\lambda_o = -98.00$

[8]

Consider the following two tables in ArcGIS and the **Join Data** operation illustrated operating on the table "Watershed$"



Table

Watershed$

HydroID	HUC	Area
1	1010900	45300
2	1010902	24300
3	1010800	63200
4	1010700	75800

(0 out of 4 Selected)

Name$ | Watershed$

Table

Name$

HydroID	Name
3	Logan
4	Bear
1	Weber

(0 out of 3 Selected)

Name$ | Watershed$

Join Data

Join lets you append additional data to this layer's attribute table so you can, for example, symbolize the layer's features using this data.

What do you want to join to this layer?

Join attributes from a table

1. Choose the field in this layer that the join will be based on:

HydroID

2. Choose the table to join to this layer, or load the table from disk:

Name$

Show the attribute tables of layers in this list

3. Choose the field in the table to base the join on:

HydroID

Join Options

Keep all records

All records in the target table are shown in the resulting table. Unmatched records will contain null values for all fields being appended into the target table from the join table.

Keep only matching records

If a record in the target table doesn't have a match in the join table, that record is removed from the resulting target table.

Validate Join

About Joining Data | OK | Cancel

Give the full table that results from this join data operation

HYDROID	HUC	AREA	HYDROID	NAME
1	1010900	45300	1	WEBER
2	1010902	24300	<null>	<null>
3	1010800	63200	3	LOGAN
4	1010700	75800	4	BEAR

[5]

Give the Area of the watershed with name "Logan" in the joined table

AREA = 63200

[3]

3. Working with Raster Data

Following is a grid of elevations in a 200 m digital elevation model.

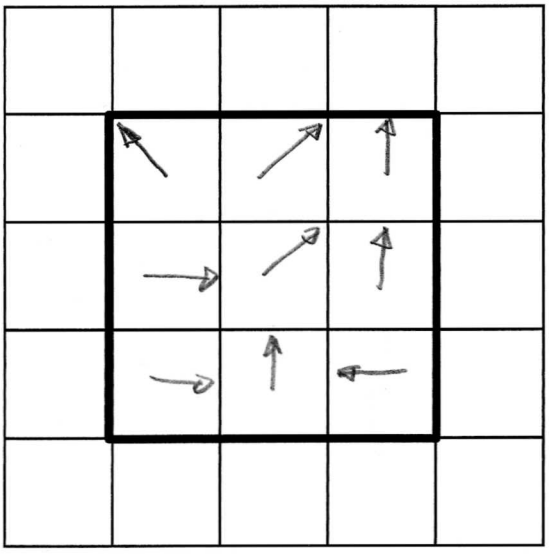
30	58	37	16	24
50	45	38	36	35
85	60	37	41	42
78	37 33	37 34	54	40
62	46	41	44	40

PITS

[5]

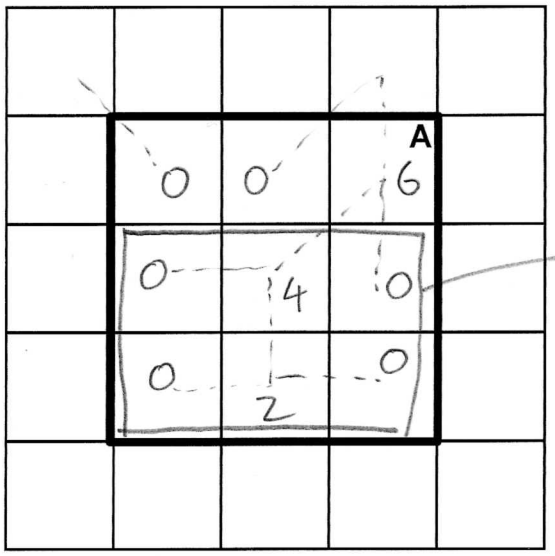
a) On the above grid, for the cells within the boldface highlighted box, determine **which grid cells are pits** and indicate the elevation to which they need to be raised to **fill** them.

b) For the inner block of 3 x 3 grid cells indicated by the bold box determine the **D8 flow direction** and indicate this using an arrow on the diagram below.



[5]

c) Calculate the **flow accumulation** for all grid cells in the inner 3 x 3 block indicated by the bold box. Write your answers (reported in terms of the number of grid cells flowing into each grid cell) in the diagram below. In this calculation do not consider inflow from any cells outside the boldface box. Indicate on the diagram the watershed draining into grid cell A and calculate its area. [Note grid cell size is 200 m x 200 m]



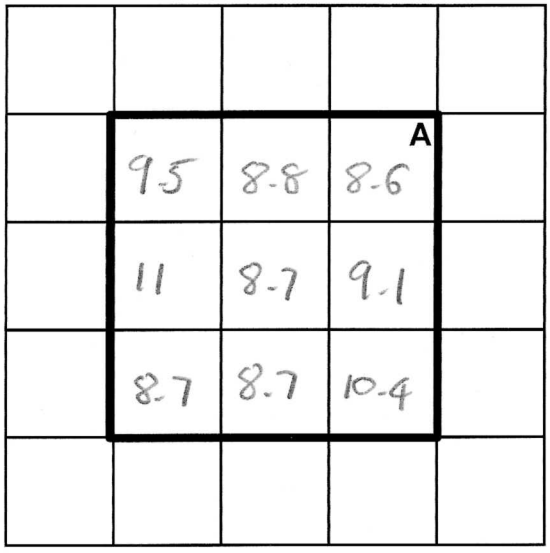
WATERSHED DRAINING IN TO A

$A = 6 * 200 * 200$

$= 240,000\ m^2$

[5]

d) Assume that this is an area where the precipitation is elevation dependent. Assume an annual precipitation elevation relationship given by P = 20 + 0.4 z, where z is elevation in m and P is precipitation in cm. Assume also that this is an area where the runoff coefficient is 0.25, meaning that 25% of precipitation appears as runoff and the balance is lost to infiltration and evapotranspiration. Calculate the depth in cm of **runoff generated** at each grid cell in the inner 3 x 3 box and write your answers on the diagram below. [note 1 cm = 0.01 m. Grid cell size 200 m x 200 m]



Doofe runoff by R

$R = 0.25\ P$

$= 0.25\ (20 + 0.4\ z)$

$= 5 + 0.1\ z$

APPLY THIS FOR EACH GRID CELL. I USED PIT FILLED Z BUT ORIGINAL Z OK TOO

[5]

e) Describe how you would implement the calculation in (d) in ArcGIS.

IN ARCGIS I WOULD USE THE FLOW ALGEBRA RASTER CALCULATOR TOOL AND EVALUATE

[ELEV] * 0.1 + 5

WHERE (ELEV) IS THE RASTER OF PIT FILLED ELEVATIONS

(5)

f) Given your results in (d) calculate the volume of flow entering grid cell A. Report your answer in m^3.

ADD RUNOFF OVER SIX CELLS COMPRISING WATERSHED OF A AND CONVERT TO m^3

$(11 + 8.7 + 9.1 + 8.7 + 8.7 + 10.9)\ cm \times 200^2\ m^2 \times 0.01\ m/cm$

$= 56.6 \times 200^2 \times 0.01 = 22640\ m^3$

(5)

[Note. These numerical values are artificial to reduce the problem to a scale where it is doable by hand. In reality, while the concept of precipitation related to elevation is sound, the value of 0.4 cm of precipitation increase for each m in elevation increase used in the equation above is unrealistic.]

4. Connecting Raster and Vector Data

(a) A geometric network has three basic components. Briefly explain what each of these consists of.

[8]

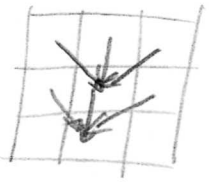
Geometry Model THIS IS THE EDGES AND JUNCTIONS REPRESENTED AS FEATURES (SEGMENTS) WITH SPATIAL COORDINATES AND MEASURE ALONG THE EDGES (x, y, z, m)

Logical Model THIS IS THE CONNECTIVITY BETWEEN EDGES & JUNCTIONS ENCODED IN A TABLE

Addressing Model THIS IS THE SYSTEM FOR LOCATING A POINT ON AN EDGE IN THE NETWORK.

(b) When modeling the flow of water through the landscape, there are two basic approaches, each of which creates elementary areas and connects them in a flow sequence. Briefly explain each of them with a diagram

Raster Approach CELL TO CELL MOVEMENT ON A RASTER GRID



[8]

Vector Approach LINE TO LINE MOVEMENT ON A NETWORK + AREA FLOWS TO LINE

How are they connected in GIS?

THE VECTOR REPRESENTATION MAY BE DERIVED FROM THE RASTER MODEL

In the United States, national coverage of the water features of the landscape is provide by the following datasets. Give a brief explanation of the contents of each dataset.

National Hydrography Dataset VECTOR STREAMLINES AND THEIR CONNECTIVITY

[9]

National Elevation Dataset ELEVATION VALUES AS A RASTER

Watershed Boundary Dataset WATERSHED BOUNDARIES BASED ON NED AND NHD AND QUALITY CHECKING.

NHDPlus ENHANCED HYDROGRAPHY WITH FLOW ATTRIBUTES AND OTHER REACH INFORMATION