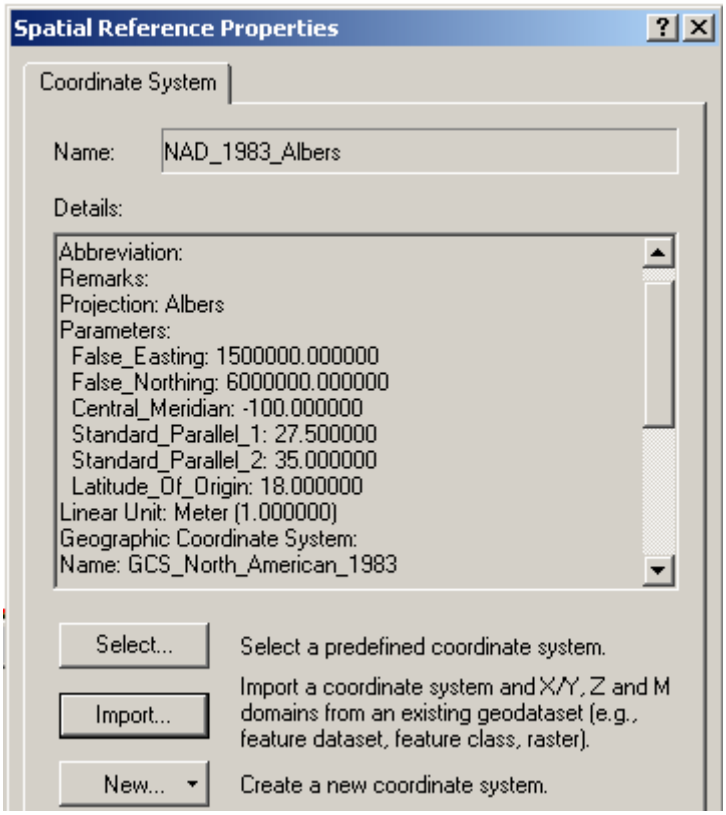
Name:_____

GIS in Water Resources Midterm Exam **Fall 2006**

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

1. [20 points] **Geodesy, Map Projections and Coordinate Systems**

Below are the spatial reference properties of the DEM used for hydrologic analysis in Exercise 4.



a) What horizontal earth datum is used?

b) What map projection is used? Why is this particular projection used for this exercise?

c) What are the geographic coordinates of the origin (φ_o, λ_o)?

d) What are the projected coordinates of the origin (X_o, Y_o)?

2. [25 points] **Distances on a Curved Earth**

Logan, Utah is located at 41°44'N, 111°50'W.
Austin, Texas is located at 30°11'N, 97°40'W.

a) Convert these coordinates to decimal degrees and indicate which of these numbers represents longitude and which represents latitude by filling the corresponding decimal degree longitude and latitude into the following table

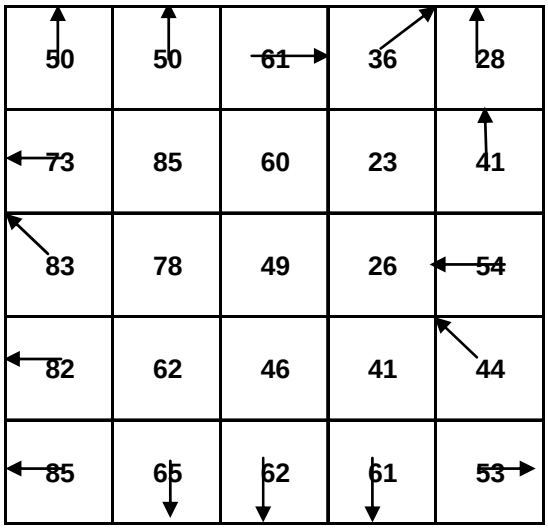
Cities	**Longitude**	**Latitude**
Logan		
Austin		

b) Assume a spherical earth with radius of 6370 km. Calculate the distance from Logan (Utah) to Austin (Texas).

c) Discuss some other ways that you have learned for calculating the distance from Logan to Austin that are not limited to assuming a spherical earth and describe how you would go about calculating this distance more precisely. (What we are looking for here is a description of how you would do this, using the GIS knowledge and tools you have learned. You are not expected to do it in this question.)

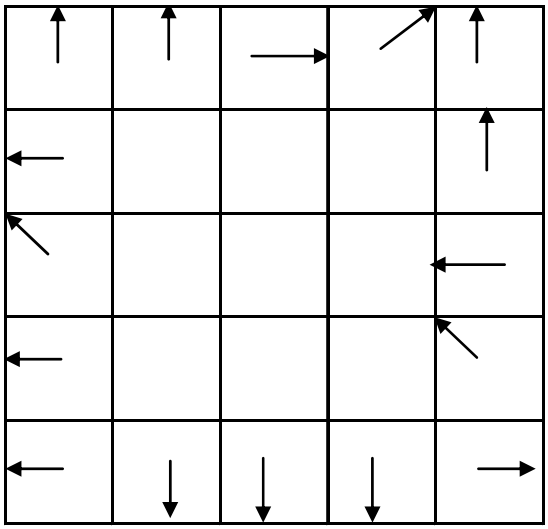
3. [30 points] **Hydrologic Variables derived from DEM's**

Following is a grid of elevations. Because in general it is not possible to unambiguously determine flow directions around the edges, these have been specified for you as indicated.

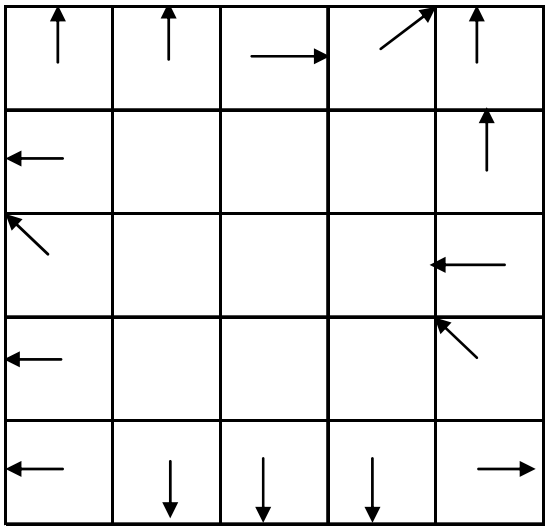


a) On the above grid, determine **which grid cells are pits** and indicate the elevation to which they need to be raised to **fill** them.

b) Determine the **flow direction grid** using the 8-direction pour point method (D8) for the 9 internal grid cells. Indicate the flow direction by using an arrow in each cell on the grid below.

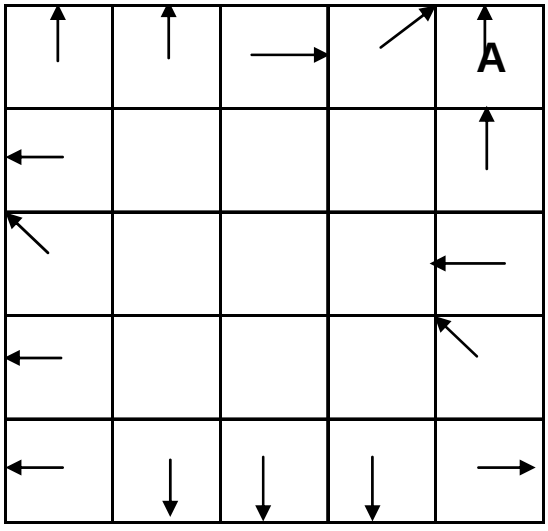


c) Determine the **flow accumulation grid** corresponding to the D8 flow directions. Label each cell on the grid below with the number of upstream cells draining **into it** (ESRI convention).



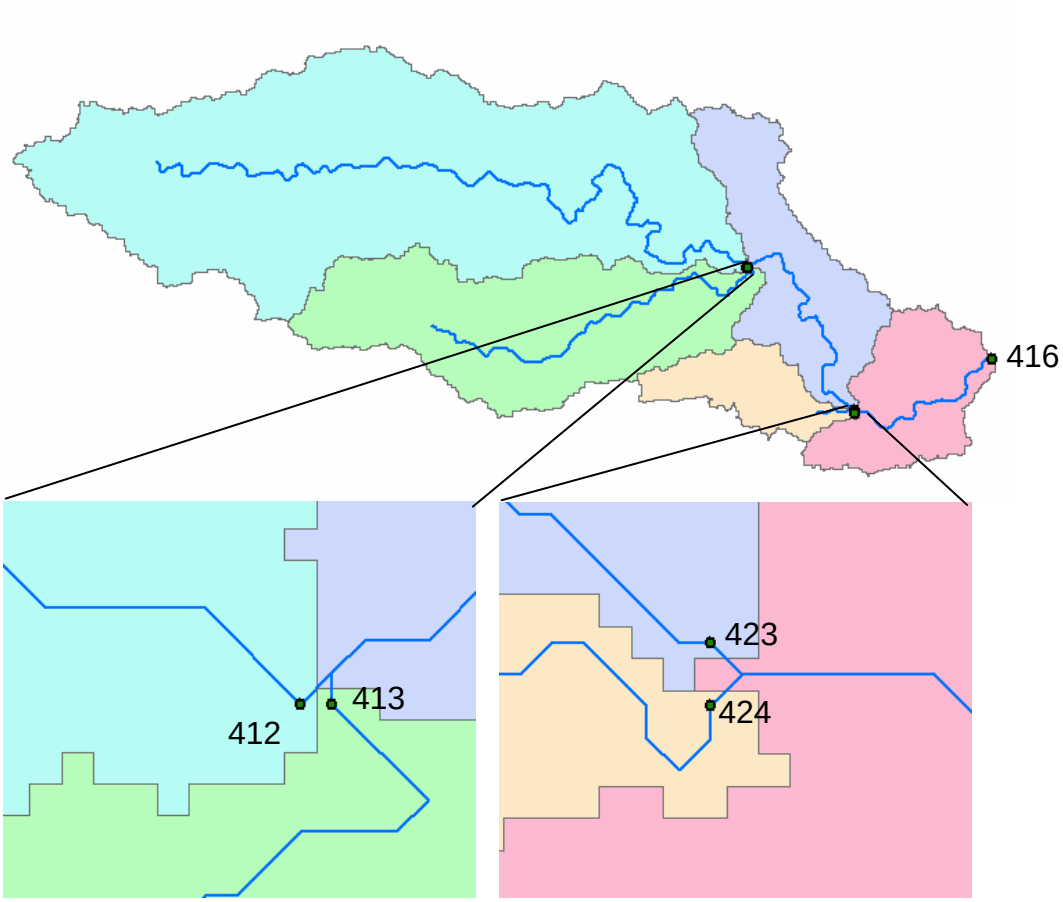
d) On the above flow accumulation grid, map the streams corresponding to a flow accumulation threshold greater than or equal to 5.

e) Assume that these are 30m grid cells and that the mean annual rainfall over this area is 750mm. Consider that on grid cells that are streams (as determined by the theshold of 5 cells above) all the rainfall becomes runoff, but that on grid cells that are not streams 80% of rainfall is lost through evapotranspiration and infiltration and only 20% of rainfall becomes runoff. Determine mean annual flow into grid cell A in m^3/year.



4. [25 points] **ArcHydro Catchments and Networks.**

Following are subsets of the "Catchment", "DrainageLine" and "Drainage Point" feature classes derived using Arc Hydro.



The drainage points have each been labeled with their HydroID. Following are the corresponding attribute tables. The units are km for length and km^2 for area.

Drainage Point

OID	HydroID	DrainID
1	412	10
2	413	14
3	416	19
4	423	13
5	424	26

DrainageLine

OID	Shape_Length	HydroID	NextDownID	DrainID
1	57	128	135	10
2	26	131	135	14
3	17	135	140	13
4	31	138	140	26
5	12	140	156	19

Catchment

OID	Shape_Length	Shape_Area	HydroID	NextDownID
1	162	437	10	13
2	99	177	14	13
3	52	69	19	18
4	76	94	13	19
5	46	392	26	19

a) On the map above (on the previous page) label each DrainageLine and Catchment with its HydroID

b) Report the area of the Catchment that drains to the point with HydroID **423**.

c) Evaluate the total length of drainage lines draining to the point with HydroID **423**

d) Evaluate the total area of the watershed draining to the point with HydroID **423**.

e) Evaluate the drainage density of the watershed draining to the point with HydroID **423**