Midterm GEOL 4880 Humphrey 07 in class, open book

point values {x}, total **30**, Questions 1,2 & 3 should be quick, question 4 is time consuming. You may elect to not answer up to 3 points.

1 a) {1} Consider an entire landscape that has only slopes that are less than the angle of repose for the landscape materials. Can you have dry landslides?

b) {1} Can you have wet landslides?

c) {1} Can there be debris flows?

d) {2} You find a fan of debris at the foot of a mountain range, and you find a road cut through it. The exposure allows you to look at a cross-section of the fan. The rocks are broken and there is a lot of fine grained material. You do see some evidence of preserved stratigraphy, with the granites overlying the more breakable shales, just like in the mountains. Somebody asks you if it is a debris flow or landslide deposit… and you say?

e) {1} Warren Hamilton (Monday's department speaker) pointed out that many Archean rocks (2+ Billion years old) show evidence of 10Km of erosion. What has been the average erosion rate?

f) {1} Make a geomorphic comment on where would you expect to find Archean rocks?

2 Assume you have gone down to the Laramie river. The water discharge is 1 m^3/s. The river is 4 meters wide and about 1/2 m deep. The river slope is $2x10^{-4}$.

a){1} What is the slope angle of the river in degrees?

b){1} What is the water flux (*flux*, not total flux)?

c){1} What is average speed of the water?

d){2} At a bend in the river, you measure the curvature of the meander bend. The radius of curvature is about 9 m. What super-elevation would you expect between the water on the inside and outside of the bend?

e){2} What is the ratio of basal water shear stress to the basal water pressure? (This question illustrates why it is usually assumed that the pressure (more precisely, the normal stress field) in fluids is isotropic, even if moving [except at very high speeds].)

f){2} Give a back-of-the-envelope number for the shear strain rate in the Laramie river (using the above data)?

3 {3} Assume that a DOT salt truck slides off the road in the Snowy Range, and dumps it load of salt into Lake Marie. Also assume that the salt dissolves quickly into the water of the lake. As a Geoscientist, you are asked to consult on this problem by a group of concerned citizens. They want to know how long the lake will be salty. List, in point form, the information *you* need, to give them an estimate of how long the salt will remain in the lake? ([hint] a complete answer should have at least 3 points, and each point should say how the data for the point would physically and practically be obtained).

4 A tree covered hillslope is mantled in 1.5 m of soil (perpendicular to slope), over solid bedrock. The soil has a dry density of 1700 kg/m^3, and a porosity of 40%. The slope is 20 degrees.

a){2} The soil creeps downslope. The shear strain rate is constant with depth and is about 0.01 per year. There is no slipping at the bedrock interface. What is the distance downslope that the surface moves in one year?

b){2} What is the volume flux of soil per unit width of hillslope?

c){3} If we wanted to model the creep movement as a 'distributed' process, we would need an estimate of C_{creep} for this hillslope region. What would be an estimate of C_{creep} (in units of m^2/yr) based on the information from this slope?

d){2} If the soil was saturated during a heavy rain, with the water table at 0.5 m below the surface (water table thickness of 1m). What would be the estimate of water pressure, at the soil/bedrock interface, using the shallow-soiled hillslope approximation?

e){2} Suppose the slope were to become fully saturated and fail as a debris flow. It stops on the toe slope at an angle of 5 degrees and a depth of 1 m, what was the critical yield stress (τ_c) in the debris flow? ([hint] remember to add the weight of water)

f){2} What role(s) does the tree cover have in the potential stability of the above slope?