

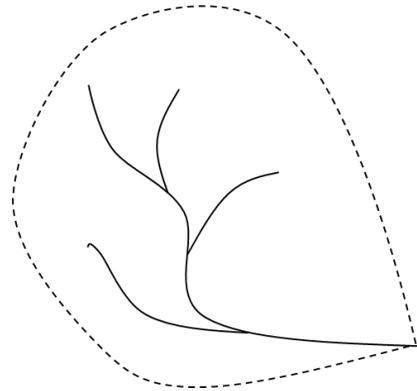
Physical Hydrology for Ecosystems  
BEE 3710

**Midterm Exam:**

- This is an open book test!
- Put your name on all pages.
- Show your work (**NEATLY**) and, if you use any data from the text or other sources, site the source(s) and pages numbers or whatever is appropriate.

**Short answer / Conceptual (10 pts each)**

- 1) This past Tuesday morning there was a heavy frost on the ground but on Wednesday there was almost no frost. Interestingly the air temperatures were pretty similar both nights. Explain why frost developed one night but not the other.
  
  
  
  
  
  
  
  
  
  
- 2) In the figure below, the dashed line is a watershed boundary and the solid lines are stream channels. What is the highest order stream in this watershed?



- 3) Worm holes and other soil macropores are potential rapid transport pathways for contaminants to groundwater. Why does water tend to flow in upstate NY's macropores more often in April and May than in August and September?
  
  
  
  
  
  
  
  
  
  
- 4) We discussed the interesting observation that pan evaporation appears to have steadily decreased over much of the planet during the 20<sup>th</sup> century. What was the paradoxical explanation for this?

- 5) Explain the hydrological concept of “variable source areas.” Source of what? What is variable?

**Calculations (10 pts each) – show work**

- 6) (a) Consider a local 150 ha (1 ha = 10000 m<sup>2</sup>) watershed that receives an average annual precipitation of 0.6 m yr<sup>-1</sup> and an average stream discharge of 70 m<sup>3</sup> hr<sup>-1</sup>. Assuming no significant amount of water enters or leaves the watershed as groundwater, cloud water, human conveyance, etc., what is the average annual evapotranspiration rate [mm d<sup>-1</sup>]?

(b) If the stream water flowing from the watershed in question has an average chloride concentration of 0.1 g m<sup>-3</sup>, how many kg of chloride leave the watershed each year?

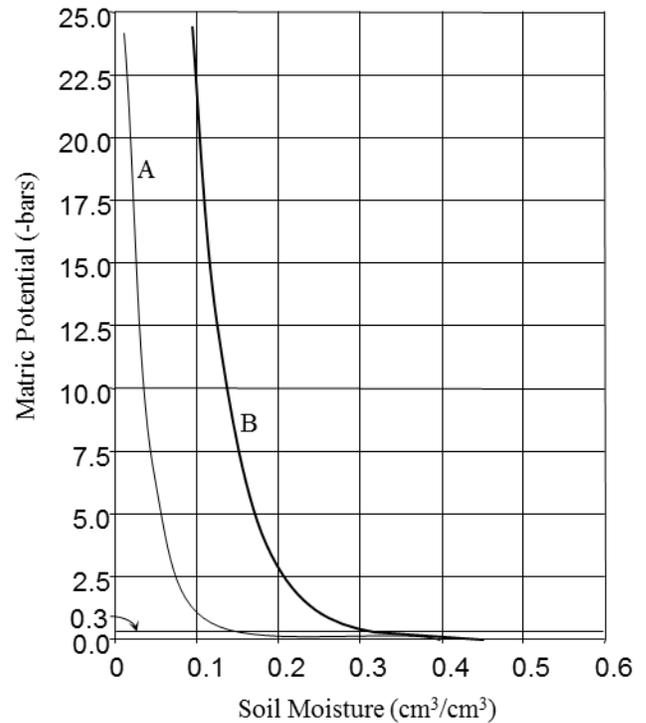
(c) If the primary source of the chloride is rainwater, what is the average concentration in the rain?

- 7) If the air on the coast of Washington State is 15°C and flows over the Cascade Mountains (~20,000 feet [6100 m] high), what will be the temperature of the air on the downwind side of the mountains (elevation 1500 feet [460 m])? Assume clouds form at ~5,000 feet [1500 m] on the windward side of the mountain.

8) Consider two soils, A and B, with soil-moisture characteristics curves shown in the graph below. Soil A is 30 cm deep and soil B is 20 cm deep.

(a) Which has the highest available water capacity?

(b) If soil A was initially at a moisture content of 0.1 and soil B was initially at a moisture content of 0.2 before 2 cm of rain fell, how deep would the wetting front be assuming the Green and Ampt concept of infiltration (the saturated moisture content is 0.40 and 0.45 for A and B, respectively).

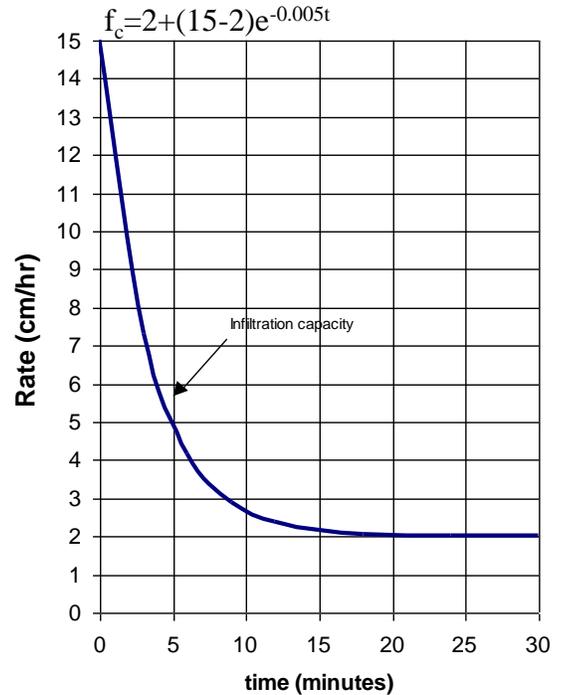


(c) If the water redistributed itself to a uniform moisture content in each soil, what would they be.

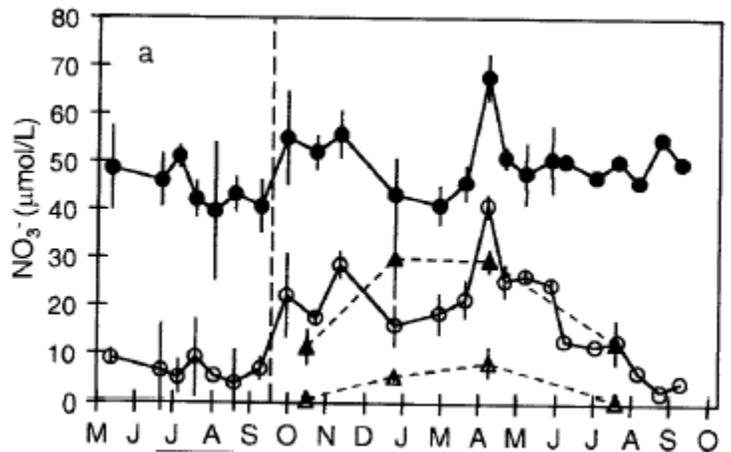
(d) Would you expect either soil to experience drainage (either as interflow or a vertical percolation) after the rain storm? Why?

- 9) Consider a soil characterized by this infiltration capacity curve.

How much infiltration and runoff would occur if this soil were subjected to a 20-minute rainfall event with an average intensity of  $3 \text{ cm hr}^{-1}$ ? When would runoff begin? (Hint, how much water does one square on the graph represent?).



- 10) The graph below shows average monthly nitrate concentrations in stream water flowing from two forested watersheds, one that was recently clear-cut and one that is an old growth watershed. Do the open or closed circles represent the old growth? Explain.



**EXTRA CREDIT (4 pts each)**

- 1) Explain spontaneous nucleation and give an example of your own experience with this phenomenon.
- 2) Why might bare soils generate Hortonian flow even if a double ring infiltrometer measurement shows the saturated hydraulic conductivity is higher than the rain intensity?
- 3) In question (7), what was the relative humidity of the air on the Washington coast?