

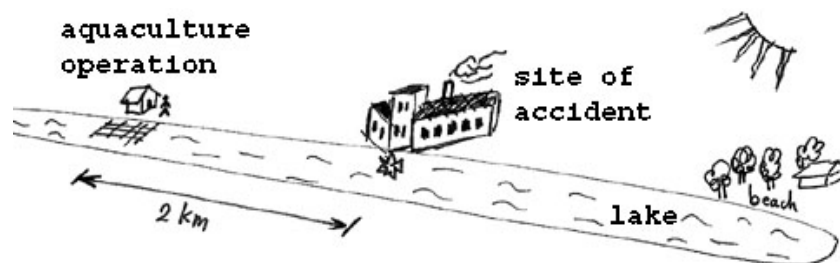
**ENGS-43, Winter 2008**  
**ENVIRONMENTAL TRANSPORT & FATE**

**HOMEWORK #2**

Assigned: Friday 18 January 2008

Due: 11:15am, Wednesday 23 January 2008

1. (10 points) Three hours ago, one of your employees accidentally spilled 80 kg of chlorides in an elongated lake. This lake has a well mixed cross-section of  $2000 \text{ m}^2$ , a slow longitudinal diffusion coefficient of  $20 \text{ m}^2/\text{s}$ , and negligible flow. Two kilometers from the point of the accident is an aquaculture operation. How has the chlorine concentration varied at that site over the last three hours and how will it evolve in the hours and days to come? Do you have time to notify the aquaculturist that pollution is on its way, or has the worst already passed? What kind of information would you give to the aquaculturist?



2. (10 points) In an infinitely long one-dimensional system, two instantaneous releases of equal magnitude  $M$  occur at the same time (say  $t = 0$ ) and at a distance  $L$  apart from each other (say  $x = 0$  and  $x = L$ ). What is the maximum concentration value reached over time at the middle point (at  $x = L/2$ )?

*(Two more questions on reverse side)*

3. (10 points) You know that a factory continuously discharges through a single pipe along a canal two non-conservative contaminants, **A** and **B**. Although the factory will not release the discharge rates, you know that these two substances are by-products of a single process and therefore come in a fixed proportion, namely twice as much **A** as **B** on a mass basis. From published chemical data, you also know the decay rate of each substance,  $K_A$  and  $K_B$ , in water. The concentrations,  $c_A$  and  $c_B$ , of the two substances in the canal water are measurable, but the technique is three times more expensive for **B** than for **A**.

Design a method relying on concentration measurements that allows you to determine the discharge rate of each contaminant at the least cost. (Assume no flow in the canal.)

4. (10 points) In Lake Michigan, a barge accidentally spilled 350 kg of a conservative contaminant 500 m from shore and within a brief amount of time. Assuming rapid mixing in the vertical, a uniform depth of 12 m in the area, a straight coastline and a horizontal diffusivity of  $3.0 \text{ m}^2/\text{s}$ , trace over time the concentration of the contaminant at the location of the spill and at the nearest point along the shore. Discuss your findings.

