Problems Illustrating Step Inputs of Pollutants into A Stream

1. A stream passes through a farming area which applies large amounts of phosphate fertilizer to the land. During rain storms the area adjacent to the stream releases fertilizer into the stream at a rate of 5.0 kg/s. The average dimensions of the stream are 20 m in width and 3 m in depth and the stream has a slope of 0.00085. The average water velocity in the stream is 0.35 m/s. (a) What is the concentration of phosphate downstream from the farm area. (b) If the phosphate is taken up by bacteria at a first-order rate of 0.000005/s, what is the equilibrium concentration in the stream 10 km downstream from the farming area. How does the compare with you results from part a?

2. The farming operation described in problem 1 also using a variety of pesticides. During the most intensive application of parathion, it is released into the same stream at a rate of 0.01 kg/s over the entire reach of the stream. If the decay rate of parathion in the stream is 5.33×10^{-3}/d, determine the concentration of parathion in the stream as a function of distance (up to 50 km). What is the concentration at 20 km downstream from the farming operation?

3. A chemical plant is located on a large river (width of 50 m, average depth of 13 m, slope of 0.00001, and water velocity of 0.13 m/s). Effluent from an industry contains phenol and is continuously released at a rate of 10 kg/s. Determine the concentration profile of phenol in the river (as a function of distance). What is the concentration at 15, 15, and 50 km downstream for the point source.

4. A stream is located next to a hazardous waste site that leaches 4-nitrophenol into the stream at rate of 1.5 kg/s. The stream has a width of 10 m, average depth of 0.8 m, and an average water velocity of 1.4 m/s. The stream slope over the distance of interest is 0.0015. Determine the concentration gradient of the chemical if the first-order decay rate is 8.18×10^{-7} s^{-1}.