Problem Set 5

CEEG 340–Introduction to Environmental Engineering
Instructor: Deborah Sills

Due Date

Wednesday, September 26

Problems

1. *(19 points)* A tanker truck carrying ethanol has a crash and spills 500 lbs of ethanol into a river adjacent to the road. The good news is that if enough oxygen is available, all of the ethanol will be biodegraded by native aerobic microbes in the river. The unbalanced chemical reaction is:

   $$C_2H_5OH + O_2 \rightarrow CO_2 + H_2O$$

   If all of the ethanol in the river is biodegraded (and converted to CO_2 and H_2O), calculate

   (a) kg of oxygen consumed

   (b) kg of CO_2 produced

   (c) cubic meters of CO_2 produced at 1 atm and 30 ^{0}C?

2. *(19 pts)* An industrial plant discharges 100 kg/day of liquids into a disposal pond. Measurements show that 1 kg/day seeps out of the bottom of the pond into the ground and 2 kg/day evaporates into the air. What is the rate of mass accumulation in the pond?

3. *(19 pts)* Each day 3780 m^3 of wastewater is treated at a municipal wastewater treatment plant. The influent contains 220 mg/L of suspended solids. The "clarified" water (after removal of solids) has a suspended solids concentration of 5 mg/L. Determine the mass of sludge produced daily from the clarifier. (Sludge = suspended solids removed by clarification from the influent).

4. *(19 pts)* **FE Formatted Question (Multiple Choice)**
   A 350 m^3 retention pond that holds rainwater from a shopping mall is empty at the beginning of a rainstorm. The flow rate out of the retention pond must be restricted to 320 L/min to prevent downstream flooding from a 6-hour storm. What is the maximum flow rate (in L/min) into the pond from a 6-hour storm that will not flood it.

   (a) 5,860 $\frac{L}{min}$

   (b) 321 $\frac{L}{min}$

   (c) 1,290 $\frac{L}{min}$

   (d) 7,750 $\frac{L}{min}$

   Show your work even though you wouldn't have to for the FE.

5. *(24 pts)* As illustrated in the figure below, a river flows into a reservoir that is being used to irrigate farmland. The river inflow is 30,000 $\frac{m^3}{yr}$ and the salt concentration in the river is 300 $\frac{g}{m^3}$. The reservoir can be modeled as being *completely mixed* with a uniform salt concentration.

   The farmland needs irrigation water to flush salts out of the soil and for use by plants. Water used by plants is lost by evapotranspiration and the net amount of this loss over and above the water input from rainfall, Q_E, equals 10,000 $\frac{m^3}{yr}$.

   Salty water from the farm is returned to the reservoir. The salt concentration in the return flow is 2,500 $\frac{g}{m^3}$.

   You may assume that the whole system is at steady state with unchanging flows and constant salt concentrations in the river, the agricultural return flow, and the reservoir.

   Find:

   (a) the flow out of the reservoir, Q_{out}.

   (b) the salt concentration in the reservoir, which is the same as the concentration in the flow out of the reservoir (since the reservoir is completely mixed).

   (c) the flow rate for the irrigation water, Q_{irr}. Note that this is different from the rate of the return flow.