

CE 440

Homework #2

Due Monday, September 12, 2005

Problem 1. Pollutant concentrations in water are frequently reported in units of ppm or mg/l. What is the difference between ppm and mg/l? When are these units of concentration essentially equivalent?

Problem 2. Show that the drinking water standard of 10 mg/L nitrate as nitrogen is equivalent to 45 mg/L nitrate. How is nitrate related to TN and TKN?

Problem 3. Explain the difference between *combined* and *separate* sewer systems. In your opinion, which type of system is more environmentally benign? List at least three factors that support your opinion.

Problem 4. Explain the concept of the “first flush” as it applies to NPS in general (not just CSOs). Briefly describe two hypothetical scenarios (agricultural or urban) besides CSOs: One scenario where a first flush occurs, and one scenario where a first flush does not occur.

Problem 5. Assume that the Pb data in Box 3.2 are **annual maximum** EMCs for 1997 through 2005. Estimate the median, 90th, and 95th percentiles: 1) nonparametrically with Eq. 3.12, 2) assuming a normal distribution, and 3) assuming a lognormal distribution. Estimate the two-year, 10-year, and 25-year return period EMCs assuming a normal and lognormal distribution. What is the longest return-period EMC than can be estimated nonparametrically?

Problem 6. Use the NURP data and methodology to estimate the annual unit loads and 90th percentile EMCs of nitrite+nitrate as nitrogen (mg/l) and Total Zn (ug/l) from a typical urban residential area. The following information is given:

Climate: Humid temperate with annual precipitation of 40 inches

Rainfall- runoff characteristics: ungauged but runoff volume estimated as 38% of annual ppt.

Problem 7. You have been asked to develop a preliminary TMDL assessment for Total Nitrogen (TN) for a large river basin / estuarine system that is undergoing severe eutrophication and summer fish kills due to nitrogen enrichment. Assume the following:

TN Load Characteristics

- Measured TN load at the head of the estuary = 9.7 million pounds per year
- NPDES permitted discharges = 5.1 million pounds of TN per year
- Average load-weighted travel distance of point source discharges = 70 miles
- Average flow velocity (USGS gauges and tracer studies) = 18 miles per day
- Instream decay of point source TN follows exponential first order decay with $k_t = 0.2 / \text{day}$
- Export coefficients (unit loads) by land use category provided in Table 1
- Preliminary assessment does not require loading estimates from septic systems and animal operations in sub/urban and agricultural contexts, respectively

River Basin Characteristics

- Cultivated Agricultural Land = 1330 square miles
- Managed Herbaceous Land (25% lawns / golf courses, 75% pasture / hay) = 214 square miles
- Developed / Urban Land = 300 square miles
- Natural / Managed Forests and Wetlands = 3020 square miles
- Open Water (upstream of estuary head) = 58 square miles

Table 1. Export coefficients for use in TN Loading Calculations (Based on Dodd and McMahon 1992)

Land Use	Median Export Coefficient (lb/acre-yr)	Number of Studies
Urban	8.1	78
Cultivated	13.6	77
Managed Herbaceous	4.4	77
Forest / Wetland	1.7	36
Open Water (direct deposition)	8.8	7

- a) Create a pie chart that allocates the measured load of TN delivered to the estuary among land use categories and point source discharges.
- b) What percentage of the estimated “edge of field” NPS load is delivered to the estuary?