Design Assignment 8.
Advanced Treatment for the Greater Drain, OR Sewage Treatment Plant

No total daily maximum load (TMDL) allocation has yet been set for the discharge of wastes into Elk Creek by the proposed POTW. Anne Arobick is concerned that this small river, which has runs of endangered coho salmon may be subjected to strict standards for nitrogen and phosphorus. They don't know whether a high level of N and P removal will be required, but they are sure that the NH_3 levels will need to be very low to protect the salmon, and it is like that total N will also be regulated.

1. Design an aeration basin to achieve complete nitrification of ammonia following the conventional aeration basin you designed in the prior assignment.
2. Because stringent N removal may be required, Ms. Arobick also wants a preliminary design of a denitrification facility.

NITRIFICATION BASIN

Since Drain is in a cool climate, a separate nitrification basin is appropriate.

Design for the average annual peak day of flow.

NH_3-N loading can be assumed to have a peaking factor of 1.5 (peak = 1.5 x Annual Mean load)

Average NH_3 concentration entering the basin = 20 mg NH_3-N/L

Minimum Operating Temperature = 10 degrees C

pH = 7.2

Average residual BOD load from the main secondary basin = 30 mg/L (no peaking applied here)

Design MLSS for the nitrification basin = 1500 mg/L

Use the first of the following two graphs to find the maximum NH_3-N loading per 1000 cu.ft. per day for the conditions above. Then, since that loading factor is for the optimal pH of 8.4, correct the maximum loading downward to the value for pH 7.2 by using the second graph. With this information:

1. Find the aeration basin volume in ft^3.
2. Find the resulting aeration period in hours.
3. Determine the oxygen uptake of the tank in lbs-O_2/day using the following information.
    1. Assume all of the residual BOD entering the basin is consumed by the nitrifiers.
    2. Remember that 1 lb of BOD, by definition, requires an oxygen uptake of 1 lb of O_2.
    3. Experimental data show that 4.6 lbs of O_2 are taken up for every pound of NH_3-N converted to nitrate. Assume we get complete conversion to nitrate.
    4. This problem is simply to find the lbs of oxygen required per day. It does not require you to make any calculations about the aeration system or the transfer efficiency, and so on. It is just a question of simple mass of oxygen required per day.

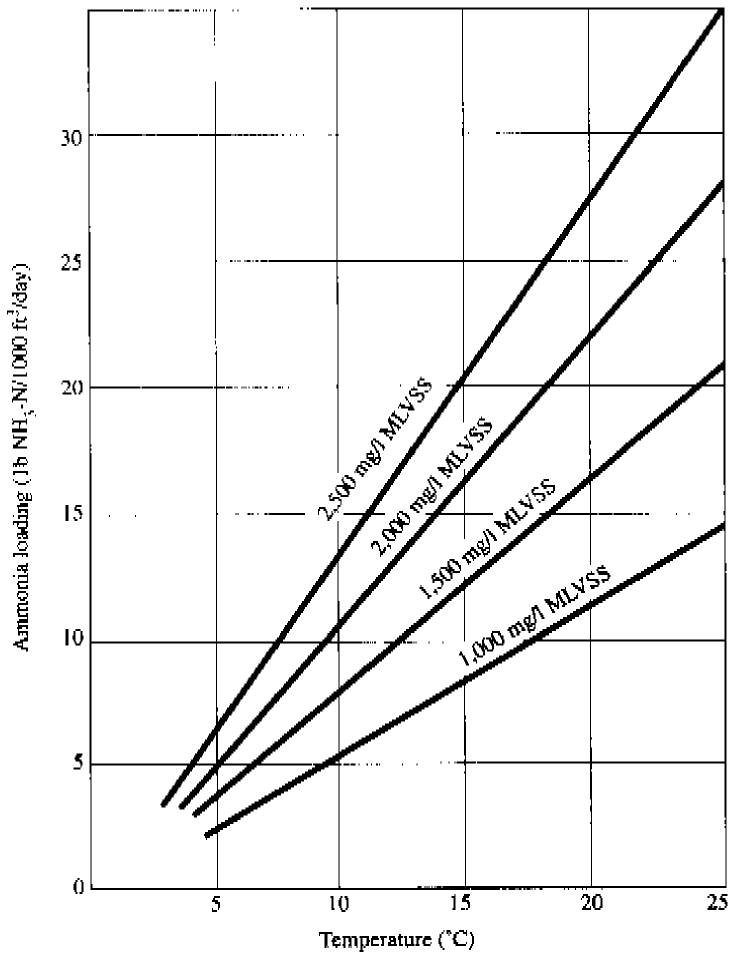

Figure 14.12 Permissible nitrification-tank loadings at an optimum pH of 8.4. [From *Nitrification and Denitrification Facilities*, Environmental Protection Agency, Technology Transfer (August 1973): 22.]

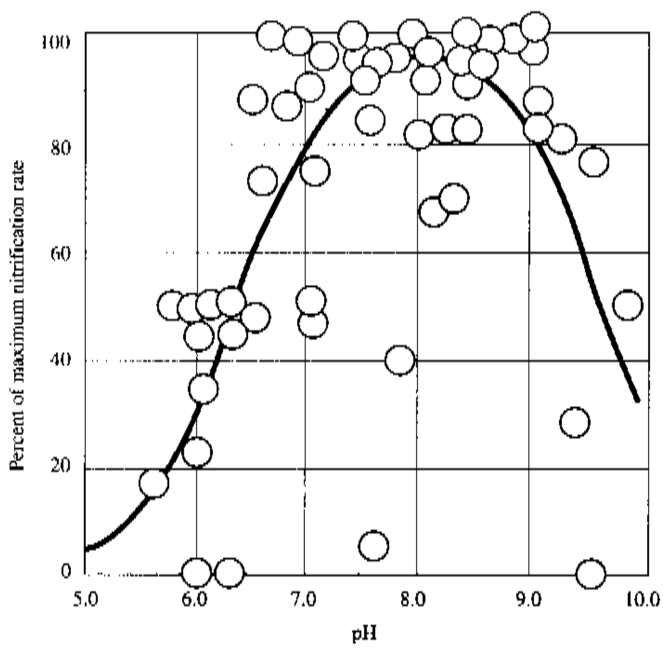

Figure 14.10 Rate of nitrification relative to maximum rate versus pH of the mixed liquor. [From: *Manual for Nitrogen Control*, Environmental Protection Agency, EPA/625/R-93/010 (September 1993): 93.]

DENITRIFICATION UNIT

Design a simple suspended growth basin that follows the denitrification unit above, in which methanol (CH_3OH) is supplied as the carbon source to achieve anoxia and denitrification.

Design for the average annual peak day of flow.

NO_3-N loading can be assumed to have a peaking factor of 1.5 (peak = 1.5 x Annual Mean load)

Minimum Operating Temperature = 10 degrees C

pH = 7.8 (slightly higher because the denitrifiers naturally run up the alkalinity)

Dissolved Oxygen entering the basin = 8.0 mg/L

Assume that at pH 7.8 the bacteria achieve 90% of the maximum denitrifying rate (optimal pH 6.5-7.5)

Design MLSS = 2000 mg/L

Use the following graph to find the loading factor for the conditions specified, taking into account the 90% correction factor for pH.

1. Find the basin volume in ft^3.
2. Find the resulting detention period in hours.
3. Find the average dose of methanol in mg/L. Methanol must be supplied to deplete the D.O. entering the tank, and then to strip out the nitrate. Experimental data show that the methanol dose in mg/L = 0.9(D.O. mg/L) + 2.5(NO_3-N mg/L). **NOTE:** This question asks you for the average dose of methanol so use the ANNUAL average (not peak daily) load of NO_3-N.
4. Find the average amount of methanol used in gal/day. Again this is the average annual (NOT peak) consumption of methanol. Methanol has a specific gravity of 0.80.

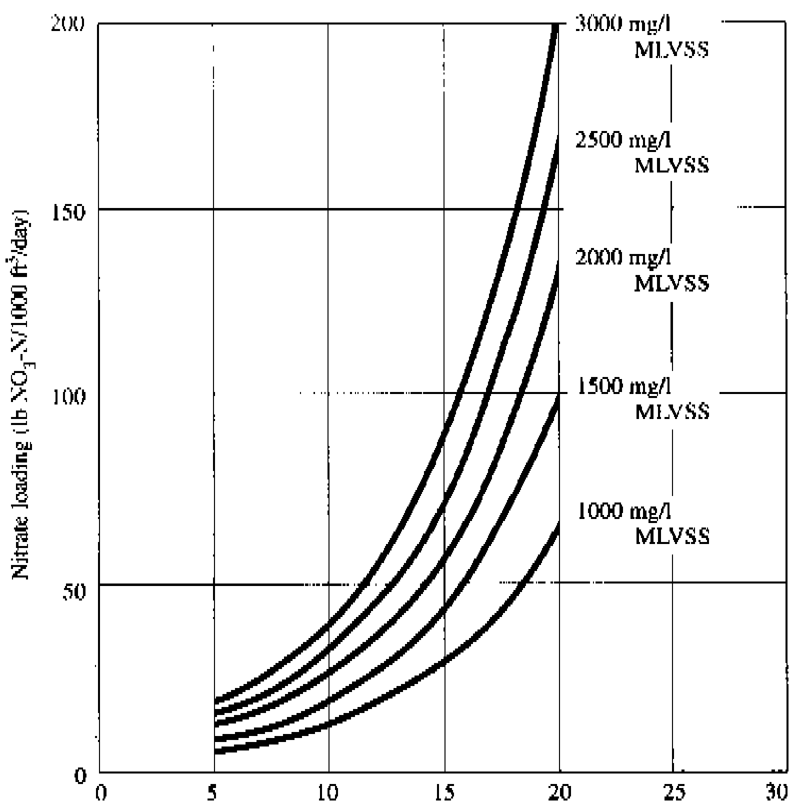

Figure 14.15 Permissible denitrification tank loadings in the pH range 6.5–7.5. [From *Nitrification and Denitrification Facilities*, Environmental Protection Agency, Technology Transfer (August 1973), 30.]