HW #6
Animal Waste Volume and Treatment Lagoons

BAEN 465

1. Given:
Cattle feedlot with 50,000 cows (finishing cattle). The finishing time = 153 days.

Required:

a. Calculate the waste mass for:
   i. excreted wet in metric tons/day and tons/day.
   ii. excreted dry solids in metric tons/day and tons/day.

b. The volume (as excreted) generated on a daily basis in m$^3$/d and ft$^3$/d.

c. Estimate the mass of waste as removed from the feedlot in metric tons/day and tons/day. Assume no bedding is used in the operation.

Hint: Use ASAE D384.2 Manure Production and Characteristics handout.

2. Given:
A broiler operation that has 10 houses which hold 25,000 birds each. The operation produces 6 batches of broilers annually with an average finishing time of 48 days per batch.

Required:

a. Estimate the annual mass of waste as removed, including litter
b. Estimate the amounts (mass) of nitrogen, phosphorus and potassium in the waste in kg/yr.

Hint: Use ASAE D384.2 Manure Production and Characteristics handout.

3. Given:
An anaerobic lagoon is used to handle the waste and wash water generated by an egg laying operation near Knoxville, TN. The operation houses 25,000 laying hens and relies on a flush system to remove manure from the houses. The flush system uses fresh water at approximately 0.25 gal/bird·d. In addition, an on-site egg washing facility uses another 600 gal/d of fresh water. No bedding is used in the operation. The depth of the lagoon is limited to 15 ft. The lagoon sides are 3 : 1 (horizontal : vertical) to ease access and side slope maintenance. The lagoon is pumped out every 90 days, and clean out of sludge occurs about every 10 years. The location where the lagoon is sited receives runoff from an upstream area of 2.5 acres. Design for a 25-yr / 24-hr rainfall event and assume 100% runoff. Assume a square lagoon and use 2 ft. of freeboard. Find the dimensions of the lagoon.

Required:

a. Calculate the Minimum Design Volume (MDV) in ft$^3$.

b. Find the Waste Storage Volume (WSV) in ft$^3$.

Hint: This includes livestock manure volume and the wastewater flush and wash volume.

c. Find the runoff volume (RV) in ft$^3$. 
d. Find the Sludge Volume (SSV) in ft$^3$.

e. Find the lagoon Total Volume in ft$^3$.

f. Find the length along the bottom of the lagoon ($l_b$) in feet.

g. Find the length at the maximum water line along the lagoon ($l_t$) in feet.

h. Find the length at the top of the lagoon embankment ($l_T$) in feet.

Hint: Use ASAE D384.2 Manure Production and Characteristics handout.
Hint: Use the Lagoon Treatment handout.
Hint: 1 ft$^3$ = 7.48 gal

4. Given:

A two-stage anaerobic lagoon system (primary and secondary lagoons) is used to treat the liquid waste from a dairy in Erath County, TX. Effluent from the primary anaerobic lagoon flows into a secondary holding lagoon. The dairy houses 2,500 cows in freestall barns with compost used as bedding. The barns are flushed three times daily using 20,000 gal of water recirculated from the holding lagoon for each flush. In addition, 30 gal/cow·d fresh water is used for washing the cows and manure flushing in the milking parlor. Approximately 0.5 lb bedding solids per cow enters the flush stream daily along with all the manure generated. The bedding contains 83% volatile solids and has a bulk density of 32 lb/ft$^3$. All the flush water flows over a static screen which retains 25% of the manure and bedding solids. Liquid from the screen flows to the primary lagoon. The lagoons are situated such that no runoff from surrounding land enters them. You may assume that sludge clean-out will occur every 10 years and pump out of the lagoon will occur every 120 days. Determine the minimum volume required for the primary lagoon and the minimum volume for the secondary lagoon. Assume the primary lagoon provides room for treatment and sludge storage and all other volumes needed are provided in the secondary lagoon. Each lagoon has a length-to-width ratio of 4 to 1 and is 15 ft deep.

Required:

For the Primary Lagoon (Include MDV and SSV only)

a. Calculate the Minimum Design Volume (MDV) in ft$^3$.
Hint: Remember that some of the solids are captured by the static screen.
Hint: Remember that some of the compost bedding will be in the flush water and that only a percentage of the bedding are volatile solids.

b. Calculate the Sludge Volume (SSV) in ft$^3$.
Hint: Remember that some of the solids are captured by the static screen.
Hint: Remember that some of the compost bedding will be in the flush water.

c. Calculate the primary lagoon Total Volume (TV) in ft$^3$.

For the Secondary Lagoon

d. Find the Waste Storage Volume (WSV) in ft$^3$.
Hint: This includes livestock manure and bedding volume and the wastewater flush and wash volume.
Hint: Remember that some of the solids are captured by the static screen.
e. Calculate the amount of rainfall captured by both the primary and secondary lagoons for a 25-yr / 24-hr rainfall event in ft$^3$.
   Hint: Remember that the maximum depth is limited to 15 ft.
   Hint: Ignore freeboard.

f. What is the secondary lagoon volume in ft$^3$ when rainfall is added?
   Hint: Assume that all captured rainfall ends up in the secondary lagoon.
   Hint: Use ASAE D384.2 Manure Production and Characteristics handout.
   Hint: Use the Lagoon Treatment handout.