1. How many pounds of solids are pumped to a digester each day if the digester receives 10,000 gpd of sludge at 5% density.

   Solution:

   $$lbs\ \ solids = \frac{10,000\frac{\cancel{gal}}{D}}{1,000,000\frac{\cancel{gal}}{MG}} MGD * (5 * 10,000)\frac{mg}{l} * 8.34 = \boxed{4,170\ \ lbs\ \ solids}$$

2. If a clarifier has a capacity of 0.25 MG, what is the detention time in hours if it receives a flow of 3 MGD

   Solution:

   $$Clarifier\ \ detention\ \ time\ \ (hr) = \frac{Clarifier\ \ volume(MG)}{Influent\ \ flow\ \ (MG/hr)}$$

   $$Clarifier\ \ detention\ \ time\ \ (hr) = \frac{0.25\cancel{MG}}{\frac{3\cancel{MG}}{\cancel{day}} * \frac{\cancel{day}}{24hrs}} = \boxed{2hrs}$$

3. If a plant removes 35% of the influent BOD in the primary treatment and 85% of the remaining BOD in the secondary system, what is the BOD of the raw wastewater if the BOD of the final effluent is 20mg/l

   Solution:

   Influent BOD: X $\frac{mg}{l}$ → *Primary* → Primary Effluent BOD: X*(1-0.35)=0.65X $\frac{mg}{l}$ → *Secondary* → Secondary Effluent BOD: 0.65X-(0.65X*0.85)=0.65X*(1-0.85)

   ↓ (X*0.35)BOD Removed ↓ (0.65X*0.85)BOD Removed

   $$0.65X * (1 - 0.85) = 20\ \ (which\ \ is\ \ the\ \ given\ \ secondary\ \ (final)\ \ effluent\ \ BOD)$$

   $$\implies X = \frac{20}{0.65 * 0.15} = \boxed{205\frac{mg}{l}}$$

4. A treatment plant receives a flow of 3.5 MGD. If the clarifier is 100 ft long, 30 ft. wide and 15 feet deep, what is the surface loading rate

   Solution:

   $$Clarifier\ \ surface/hydraulic\ \ loading\ \ \left(\frac{gpd}{ft^2}\right) == \frac{\frac{3.5\cancel{MG}}{day} * \frac{10^6 gal}{\cancel{MG}}}{100 * 30ft^2} = \boxed{1,167gpd/ft^2}$$

   Note: We use the length and width of the clarifier to find the surface area. The depth of water is irrelevant

5. What is the surface area of a pond (in acres) that is 4 ft deep, if it holds 30 million gallons

   Solution:

$$Volume = Surface\ \ Area * Depth \implies Surface\ \ Area = \frac{Volume}{Depth}$$

$$\implies Surface\ \ Area(acres) = \frac{Volume(acre-ft)}{Depth(ft)} = \frac{\frac{30{,}000{,}000 \cancel{gal} * \frac{\cancel{ft^3}}{7.48 \cancel{gal}}}{\frac{43{,}560 \cancel{ft^3}}{acre-ft}}}{4ft} = \boxed{23\ \ acres}$$

6. Primary sludge containing five (5%) solids is pumped to a digester continuously at a rate of 25 gpm. How many pounds of volatile solids are added to the digester each day if the volatile solids content is 73% of the total solids?

$$lbs\ \ volatile\ \ solids\ \ VS = \frac{25 \frac{\cancel{gal}}{\cancel{min}} * \frac{1440 \cancel{min}}{day}}{1{,}000{,}000 \frac{\cancel{gal}}{MG}} MGD * (5 * 10{,}000) \frac{\cancel{mg\ \ total\ \ solids}}{l} * 0.73 \frac{mg\ \ volatile\ \ solids}{\cancel{mg\ \ total\ \ solids}} * 8.34 = \boxed{10{,}959\ \ lbs\ \ VS}$$

7. In a 2.1 MGD wastewater treatment plant the influent suspended solids concentration to the primary clarifier is 240 mg/l. The primary sludge contains 3.2% TSS and the primary effluent has a suspended solids concentration of 125mg/l. How many gallons sludge should be pumped per day?

Solution:

$$\xrightarrow[240 \frac{mg}{l} Influent\ \ TSS]{\text{2.1 MGD Flow}} \boxed{Primary} \xrightarrow[125 \frac{mg}{l} Primary\ \ Effluent\ \ TSS]{}$$

$$\downarrow \text{(240-125)} \frac{mg}{l} TSS\ \ Removed\ as\ \ sludge$$

$$lbs\ \ solids\ \ removed = (240-125) mg/l * 2.1 MGD * 8.34 = 2{,}014\ \ lbs\ \ solids\ \ per\ \ day$$

$$\frac{gallons\ \ sludge}{day} = \frac{2{,}014\ \cancel{lbs\ \ solids}}{day} * \frac{1\ \cancel{lb\ \ sludge}}{0.032\ \cancel{lbs\ \ solids}} * \frac{gal\ \ sludge}{8.34 \cancel{lb\ \ sludge}} * = \boxed{7{,}546 \frac{gal\ \ sludge}{day}}$$