APPLIED WASTEWATER MATH FORMULA SHEET
AND CONVERSION FACTORS

12 in = 1 ft  
3 ft = 1 yd  
5,280 ft = 1 mi  
144 sq in = 1 ft²  
43,560 ft² = 1 acre

27 cu ft = 1 cu yd  
7.48 gal = 1 cu ft  
8.34 lbs = 1 gal water  
62.4 lbs = 1 ft³ water

1,000 mg = 1 gm  
1,000 gm = 1 kg  
1,000 ml = 1 liter  
2.31 ft water = 1 psi

60 sec = 1 min  
60 min = 1 hour  
1,440 min = 1 day  
454 gm = 1 lb

3 ft = 1 yard  
7.48 gal = 1 cu ft  
1,000 gm = 1 kg  
60 min = 1 hour

5,280 ft = 1 mile  
8.34 lbs = 1 gal water  
1,000 ml = 1 liter  
1,440 min = 1 day

144 sq in = 1 ft²  
62.4 lbs = 1 ft³ water  
2.31 ft water = 1 psi  
10,000 mg/L = 1%

43,560 ft² = 1 acre  
746 watts = 1 hp  
1,000 ml = 1 liter  
1,000 mg/L = 1%

L = Length  
B = Base  
π = 3.14  
W = Width  
H = Height  
R = Radius

Q = Flow Rate  
A = Area  
V = Volume  
v = velocity  
SG = Specific Gravity

Chlorine Demand (mg/L) = dosage (mg/L) – residual (mg/L)

AREA

Rectangle: A = L x W  
Triangle: A = ½ B x H  
Circle: Area = πR²

VOLUME

Cylinder: V = πR²H  
Rectangle: V = L x W x H  
Cone: V = 1/3πR²H

VELOCITIES and FLOW RATES

1. Velocity = distance  
   time

2. Q = v x A

DETENTION TIME

Detention Time = \( \frac{V}{Q} \)

PARTS PER MILLION / POUNDS

lbs = 8.34 lbs / gal x mg/L x MG x SG

SEDIMENTATION AND LOADINGS

1. Weir overflow rate = \( \frac{\text{total flow}}{\text{length of weir}} \)

2. Surface overflow rate = \( \frac{\text{Influent flow}}{\text{surface area}} \)

3. Solids Loading rate = \( \frac{\text{solids applied}}{\text{surface area}} \)
SEDIMENTATION AND LOADINGS (continued)

4. Efficiency, % = \( \frac{(in) - (out)}{(in)} \times 100\% \)

5. Organic loading rate (activated sludge) = \( \frac{\text{CBOD applied}}{V} \)

6. Hydraulic loading rate = \( \frac{Q}{A} \)

7. Centrifuge hydraulic loading: hydraulic loading rate = \( \frac{Q \times \text{run time}}{\text{run time} + \text{skim time}} \)

ACTIVATED SLUDGE

1. SVI = \( \frac{30 \text{ min settling, ml/L} \times 1,000 \text{ mg}}{\text{MLSS, mg/L}} \) gram

2. SDI = \( \frac{100}{\text{SVI}} \)

3. Solids inventory, lbs = (Tank volume, MG) x (solids concentration, mg/L) x (8.34 lbs / gal)

4. Sludge age, days = solids under aeration, lbs solids added, lbs / day

5. F/M = \( \frac{\text{CBOD applied}}{\text{Organic solids under aeration}} \)

6. MCRT = \( \frac{\text{solids inventory}}{[\text{effluent solids} + \text{WAS solids}]} \)

7. Change, WAS rate, MGD = (current solids inventory, lbs) – (desired solids inventory, lbs)

8. Return sludge rate, MGD = \( \frac{(\text{settleable solids, mL}) \times Q}{(1,000 \text{ mL})} - (\text{settleable solids, mL}) \)

SLUDGE DIGESTION

1. Dry solids, lbs = \( \frac{(\text{sludge, gal}) \times (\text{sludge, % solids}) \times (8.34 \text{ lbs / gal}) \times \text{SG}}{100\%} \)

2. Seed Sludge, lbs volatile solids = \( \frac{\text{volatile solids pumped (lbs volatile solids / day)}}{\text{loading factor (lbs VS / day) / lb VS in digester}} \)

3. Seed Sludge, gal = \( \frac{\text{seed sludge (lbs volatile solids)}}{\text{seed sludge (lbs / gal)} \times (\text{solids %}) \times (\text{volatile solids %})} \)

4. Digested sludge removed = Total sludge in – volatile solids destroyed

5. Lime required, lbs = (sludge, MG) x (volatile acids, mg/L) x (8.34 lbs / gal)
SLUDGE DIGESTION (continued)

6. Percent volatile solids reduction = \( \frac{(\text{in} - \text{out}) \times 100\%}{\text{in} - (\text{in} \times \text{out})} \)

7. VS destroyed, lbs / day / cu ft = \( \frac{\text{volatile solids added (lbs / day)} \times \text{volatile solids reduction} (\%)}{\text{digester volume (ft}^3\text{)} \times 100\%} \)

8. Gas production (cu ft / lb VS) = \( \frac{\text{gas produced (ft}^3\text{ / day)}}{\text{VS destroyed (lbs / day)}} \)

HORSEPOWER, FORCE, CHEMICAL PUMPS

1. Water HP = \( \frac{Q(\text{gpm}) \times 8.34 \text{ lbs / gal} \times \text{head (ft)}}{33,000 \text{ ft-lbs / min}} \)

2. Break HP = Water HP \( \times \) pump efficiency

3. Motor HP = BHP \( \times \) motor efficiency

4. Upward force = \( 62.4 \text{ (lbs / ft}^3\text{)} \times \text{height (ft)} \times \text{area (ft}^2\text{)} \)

5. Side wall force = \( 31.2 \text{ (lbs / ft}^3\text{)} \times \text{volume (ft}^3\text{)} \)

6. Chemical solution, lbs / gal = \( \frac{\text{(solution \%)} \times 8.34 \text{ lbs / gal}}{100\%} \)

7. Feed pump flow, gal / day = \( \frac{\text{chemical feed (lbs / day)}}{\text{Chemical solution (lbs / gal)}} \)

8. Scale setting, % = \( \frac{\text{desired flow (gal / day) (100\%)} \times \text{maximum feed rate (gal/day)}}{100\%} \)

9. Total Dynamic Head = Static Head + Friction Losses

10. Static Head = Suction Lift + Discharge Head

11. Polymer solution % = \( \frac{\text{dry polymer (lb)}}{\text{Vol of solution (gal)} \times 8.34 \text{ (lbs / gal)}} \)

LAB PROCEDURES AND MEASUREMENTS

1. TSS, mg/L = \( \frac{(\text{RDD} - \text{DD}) \times 1M}{\text{sample vol (mL)}} \)

2. VSS, mg/L = \( \frac{(\text{RDD} - \text{FDD}) \times 1M}{\text{sample vol (mL)}} \)

where: RDD = dried residue + dish + disc (filter)(grams)
DD = dish + disc, grams
FDD = fired residue + dish + disc (grams)
1M = 1,000,000
LAB PROCEDURES AND MEASUREMENTS (continued)

3. VSS, % = \( \frac{\text{volatile solids (mg/L)}}{\text{total suspended solids (mg/L)}} \times 100\% \)

4. CBOD sample size (mL) = \( 1,200 \frac{\text{estimated CBOD (mg/L)}}{\text{sample size (mL)}} \)

5. Seed correction, mg/L for 1 mL seed = \( \frac{\text{seed initial D.O.} - \text{seed final D.O.}}{\text{mL seed added}} \)

6. CBOD, mg/L = \( \left( \frac{\text{Initial D.O.} - \text{Final D.O.} - \text{seed correction factor}}{\text{sample volume (mL)}} \right) \times \text{bottle volume (mL)} \)

7. Initial D.O. = \( \left( \frac{\text{mL sample} \times \text{D.O. sample}}{\text{bottle volume (mL)}} \right) + \left( \frac{\text{mL dilution water} \times \text{D.O. dilution water}}{\text{bottle volume (mL)}} \right) \)

8. Temperature Conversion: Temperature, F = (temperature C)(1.8) + 32