

Flocculation

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Nonionic Polymer Range: $0.05 - 0.5 \text{ g/m}^3$

Low Dose

$$0.05 \text{ g/m}^3 \left(\text{m}^3 / 264.17 \text{ gal} \right) \\ = 0.0001893 \text{ g/gal}$$

$$0.0001893 \text{ g/gal (40 MGD)} \\ = 7572 \text{ g/day}$$

$$7572 \text{ g/day (lb/453.59 g)} \\ = 16.69 \text{ lbs/day}$$

High Dose

$$0.5 \text{ g/m}^3 \left(\text{m}^3 / 264.17 \text{ gal} \right) \\ = 0.001893 \text{ g/gal}$$

$$0.001893 \text{ g/gal (40 MGD)} \\ = 75,720 \text{ g/day}$$

$$75,720 \text{ g/day (lb/453.59 g)} \\ = 166.9 \text{ lbs/day}$$

Estimated Dose

$$0.1 \text{ g/m}^3 \left(\text{m}^3 / 264.17 \text{ gal} \right) \\ = 0.0003785 \text{ g/gal}$$

$$0.0003785 \text{ g/gal (40 MGD)} \\ = 15,140 \text{ g/day}$$

$$15,140 \text{ g/day (lb/453.59 g)} \\ = 33.38 \text{ lbs/day}$$



High-Rate Sedimentation

High Rate sedimentation Basin - Sizing
 40MGD = $181,843.6 \frac{\text{m}^3}{\text{d}}$

Tank Surface Area, $A_s = 181,843.6 \frac{\text{m}^3}{\text{d}} / 190 \text{ m}^3/\text{d} - \text{m}^2$
 $A_s = 1010.24 \text{ m}^2$
 3 tanks = 336.75 m^2 each ↳ assumed overflow Rate

Selected width = 4.8 m

↳ Settler length = $\frac{336.75 \text{ m}^2}{4.8 \text{ m}} = 70.16 \text{ m}$

↳ tank length = $\frac{70.16}{0.75} = 93.54 \text{ m}$

SWD = 4m

Depth of Sludge = 2m
 — efficiency

Approach velocity = $\frac{60,614.5 \frac{\text{m}^3}{\text{d}}}{4.8 \text{ m} * 3.6} / 1400 * 60 = 0.041 \text{ m/s} > 0.01 \text{ m/s}$

Tube velocity = $\frac{0.584 \frac{\text{m}}{\text{s}}}{4.8 \text{ m} (\sin(1.05))} = 0.0024 \text{ m/s} < 0.0025 \text{ m/s}$
 ↳ a little slow but OK



Rapid Sand Filter Hand Calculations

Rapid Sand Filter - Basin Design

$$\# \text{ of Beds} = 0.0195 * (151416.5 \frac{\text{m}^3}{\text{d}})^{0.5} = 7.6 = 8 \text{ beds}$$

$$\text{Area of Bed} = \frac{151416.5 \frac{\text{m}^3}{\text{d}}}{8 * 293 \frac{\text{m}^3}{\text{d-m}^2}} = 64.6 \text{ m}^2$$

/
assumed
filtration rate

$$\text{Assumed Cell width} = 3.5 \text{ m}$$

$$\text{Bed length} = \frac{64.6 \text{ m}^2}{2 * 3.5 \text{ m}} = 9.23 \text{ m}$$

$$L/w = \frac{9.23 \text{ m}}{3.5 \text{ m}} = 2.64$$

$$\text{Gullet width} = 0.6 \text{ m}$$

$$\# \text{ of launders} = \frac{9.23 \text{ m}}{2 \text{ m}} = 4.62 = 5$$

$$\text{Spacing of troughs} = \frac{9.23 \text{ m}}{5} = 1.85 \text{ m}$$

$$\text{Max Particle Travel Distance} = \frac{9.23 \text{ m}}{2 * 5} = 0.92 \text{ m}$$

$$\text{Max Backwash Trough Flow} = 40 \frac{\text{m}^3}{\text{hr}} * 0.92 \text{ m} * 2 * 3.5 \text{ m} = 258.4 \text{ m}^3/\text{hr}$$

Through a figure in referenced text book:

$$W = 0.53 \text{ m} \quad Y = 0.375 \text{ m}$$

$$\text{Trough Freeboard} = 0.05 \text{ m} \quad \text{Trough Depth} = 0.64$$

$$\text{Margin of Safety} = 0.15 \text{ m}$$

$$\text{Trough Elevation} = 0.69 \text{ m} \left(\frac{1+30}{100} \right) = 0.69 \text{ m} + 0.64 \text{ m} + 0.15 \text{ m} = 1 \text{ m}$$

$$\text{Backwash Tank Volume} = 40 \text{ m}^3/\text{hr} * 9.23 \text{ m} * 0.25 * 3.5 \text{ m} * 4 = 1292 \text{ m}^3$$



Ion Exchange

Ion Exchange

Facility flow rate = 27 777.78 gpm

Flow Rate / Ion Exchange = 1000 gpm

$$\# \text{ of Units} = \frac{27\,777.78 \text{ gpm}}{1000 \text{ gpm}} = 27.78 \text{ Units} \rightarrow 28 \text{ units}$$

AOP

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Facility flow rate = 20 833.33 gpm

Flow rate per AOP unit = 1750 gpm

$$\# \text{ of Units} = \frac{20\,833.33 \text{ gpm}}{1750 \text{ gpm}} = 11.90 \text{ units} \rightarrow 12 \text{ units}$$



UV Dose

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$$D = I(t)$$

Where:

$$D = \text{UV Dose, mJ/cm}^2$$

$$I = \text{UV Intensity, mW/cm}^2$$

$$t = \text{Exposure time, s}$$

$$I = 1000 \text{ W (1000 mW/W)} / 46698.16 \text{ cm}^2$$

$$= 21.41 \text{ mW/cm}^2$$

↳ Where cross sectional area (46698.16 cm²) and power (1000 W) given by manufacturer website

$$D = I(t)$$

$$t = \frac{D}{I} = \frac{300 \text{ mJ/cm}^2}{21.41 \text{ mW/cm}^2} = \boxed{14.01 \text{ s}}$$



Final Chlorination

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$$C = 0.2 \text{ mg/L} \quad t = 4 \text{ hrs} = 0.167 \text{ d}$$

$$\text{low } k_d = 0.36 \text{ d}^{-1} \quad \text{high } k_d = 11.09 \text{ d}^{-1}$$

$$C = C_0 e^{-k_d t} \rightarrow C_0 = C e^{k_d t}$$

$$\text{low } C_0 = (0.2 \text{ mg/L}) e^{(0.36 \text{ d}^{-1})(0.167 \text{ d})} = 0.212 \text{ mg/L}$$

$$\text{high } C_0 = (0.2 \text{ mg/L}) e^{(11.09 \text{ d}^{-1})(0.167 \text{ d})} = 1.270 \text{ mg/L}$$

Brine Management/Crystallizers

Crystallizers

$$\text{Brine flow rate} = 6944.44 \text{ gpm}$$

$$\text{Flow rate per crystallizer} = 1500 \text{ gpm}$$

$$\# \text{ of units} = \frac{6944.44 \text{ gpm}}{1500 \text{ gpm}} = 4.63 \text{ units} \rightarrow 5 \text{ units}$$