Trickling Filters Criteria: (1) 50 lb/1000 ft^3/day BOD loading; (2) 0.16–0.48 gpm/ft^2 hydraulic loading.

$$\text{volume required} = \frac{0.65 \times 450 \times 1.2 \times 8.34}{0.050} = 58{,}500 \text{ ft}^3$$

volume of each filter = 29,300 ft^3

Try 6-ft depth.

$$\text{area} = \frac{29{,}300}{6.0} = 4880 \text{ ft}^2$$

Check the hydraulic loading:

$$\frac{(1.5 + 0.75)1{,}200{,}000}{4880 \times 1440} = 0.38 \text{ gpm/ft}^2 \quad \text{(OK)}$$

Use 6-ft-deep filters with a 4880-ft^2 area.

Intermediate Settling Tank Criteria: (1) 1000-gpd/ft^2 overflow rate; (2) minimum depth of 7 ft.

$$\text{area required} = \frac{1.25 \times 1{,}200{,}000}{1000} = 1500 \text{ ft}^2$$

Use a side-wall depth of 7 ft plus freeboard.

Final Settling Tank Criteria: (1) 800-gpd/ft^2 overflow rate; (2) minimum depth of 7 ft.

$$\text{area required} = \frac{1{,}200{,}000}{800} = 1500 \text{ ft}^2$$

Use a side-wall depth of 7 ft plus freeboard.

Calculation of BOD removal efficiency

primary tank = 35%

First-stage filter:

$$\text{BOD loading} = \frac{0.65 \times 450 \times 1.2 \times 8.34}{29.3} = 100 \text{ lb/1000 ft}^3\text{/day}$$

$$R = \frac{0.50Q + 0.75Q}{Q} = 1.25$$

$$E = 70\%$$

Second-stage filter:

BOD loading = $0.30 \times 100 = 30$ lb/1000 ft^3/day

$$R = \frac{0.25Q + 0.75Q}{Q} = 1.0$$

$$F = \frac{1 + 1.0}{(1 + 0.1 \times 1.0)^2} = 1.65$$

By Eq. 12.44,

$$E_2 = \frac{100}{1 + [0.0561/(1 - 0.70)](30/1.65)^{0.5}} = 56\%$$

The plant efficiency is

$$E = 100 - 100[(1 - 0.35)(1 - 0.70)(1 - 0.56)] = 92\%$$

The estimated effluent BOD is $0.08 \times 450 = 38$ mg/l.