3.19 Water from a storm drain flows over an outfall onto a porous bed which absorbs the water at a uniform vertical velocity of 8 mm/s, as shown in Fig. P3.19. The system is 5 m deep into the paper. Find the length $L$ of bed which will completely absorb the storm water.

![Fig. P3.19](image)

**Solution:** For the bed to completely absorb the water, the flow rate over the outfall must equal that into the porous bed,

$$Q_1 = Q_{PB}, \quad \text{or} \quad (2 \text{ m/s})(0.2 \text{ m})(5 \text{ m}) = (0.008 \text{ m/s})(5 \text{ m})L$$

Thus, $L \approx 50 \text{ m} \quad \text{Ans.}$

3.20 Oil (SG-0.91) enters the thrust bearing at 250 N/hr and exits radially through the narrow clearance between thrust plates. Compute (a) the outlet volume flow in mL/s, and (b) the average outlet velocity in cm/s.

![Fig. P3.20](image)

**Solution:** The specific weight of the oil is $(0.91)(9790) = 8909 \text{ N/m}^3$. Then

$$Q_2 = Q_1 = \frac{250/3600 \text{ N/s}}{8909 \text{ N/m}^3} = 7.8 \times 10^{-6} \frac{\text{m}^3}{\text{s}} = 7.8 \frac{\text{mL}}{\text{s}} \quad \text{Ans. (a)}$$

But also $Q_2 = \pi(0.1 \text{ m})(0.002 \text{ m}) = 7.8 \times 10^{-6}$, solve for $V_2 = 1.24 \frac{\text{cm}}{\text{s}} \quad \text{Ans. (b)}$