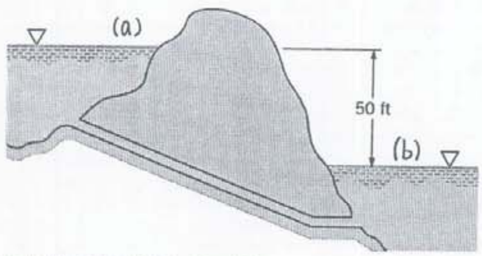
5.118

5.118 Water flows by gravity from one lake to another as sketched in Fig. P5.118 at the steady rate of 80 gpm. What is the loss in available energy associated with this flow? If this same amount of loss is associated with pumping the fluid from the lower lake to the higher one at the same flowrate, estimate the amount of pumping power required.



■ FIGURE P5.118

$$Q = \frac{80\ \frac{gal}{min}}{\left(60\ \frac{s}{min}\right)\left(7.48\ \frac{gal}{ft^3}\right)} = 0.178\ \frac{ft^3}{s}$$

For the flow from section (a) to section (b) Eq. 5.82 leads to

$$loss = g(z_a - z_b) = \left(32.2\ \frac{ft}{s^2}\right)(50\,ft)\left(\frac{1\ lb}{slug\cdot\frac{ft}{s^2}}\right) = \underline{\underline{1610}}\ \frac{ft\,lb}{slug}$$

For pumped flow from section (b) to section (a) Eq. 5.82 yields

$$\dot{W}_{\substack{shaft\\net\ in}} = \rho Q\left[g(z_a - z_b) + loss\right] = \left(1.94\ \frac{slugs}{ft^3}\right)\left(0.178\ \frac{ft^3}{s}\right)\left[\left(32.2\ \frac{ft}{s^2}\right)(50\,ft)\left(\frac{1\ lb}{slug\cdot\frac{ft}{s^2}}\right) + 1610\ \frac{ft\cdot lb}{slug}\right]$$

or

$$\dot{W}_{\substack{shaft\\net\ in}} = \underline{\underline{1110}}\ \frac{ft\cdot lb}{s} = \underline{\underline{2.02\ hp}}$$