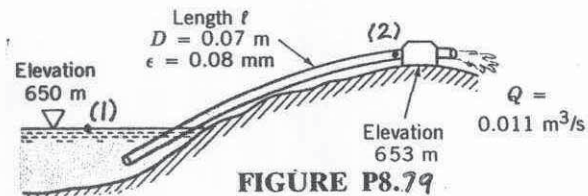8.79 Water at 10 °C is pumped from a lake as shown in Fig. P8.79. If the flowrate is 0.011 m³/s, what is the maximum length inlet pipe, ℓ, that can be used without cavitation occurring?

FIGURE P8.79

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + \left(f\frac{\ell}{D} + \Sigma K_L\right)\frac{V^2}{2g}, \quad \text{where} \quad p_1 = 101 \text{ kPa}, \ z_1 = 650 m \tag{1}$$

$V_1 = 0, \ V_2 = V, \ z_2 = 653 m$, and from Table B.2 $p_2 = p_v = 1.228 \text{ kPa}$

Also, $V = \dfrac{Q}{A} = \dfrac{0.011 \frac{m^3}{s}}{\frac{\pi}{4}(0.07m)^2} = 2.86 \frac{m}{s}$ so that

$Re = \dfrac{VD}{\nu} = \dfrac{(2.86\frac{m}{s})(0.07m)}{1.307 \times 10^{-6} \frac{m^2}{s}} = 1.53 \times 10^5$. With this Re and from Table 8.1 with

$\dfrac{\varepsilon}{D} = \dfrac{0.08mm}{70mm} = 0.00114$ we obtain $f = 0.0216$ (see Fig. 8.20)

Hence, with $\Sigma K_L = 0.8$ for the entrance, Eq.(1) becomes

$$\frac{(101-1.228)\times 10^3 \frac{N}{m^3}}{9.80 \times 10^3 \frac{N}{m^2}} + 650 m = 653 m + \left(1 + (0.0216)\left(\frac{\ell}{0.07m}\right) + 0.8\right)\frac{\left(2.86\frac{m}{s}\right)^2}{2\left(9.81\frac{m}{s^2}\right)}$$

or $\ell = \underline{\underline{50.0 \ m}}$