3.112

3.112 Water flows down the sloping ramp shown in Fig. P3.112 with negligible viscous effects. The flow is uniform at sections (1) and (2). For the conditions given show that three solutions for the downstream depth, h_2, are obtained by use of the Bernoulli and continuity equations. However, show that only two of these solutions are realistic. Determine these values.

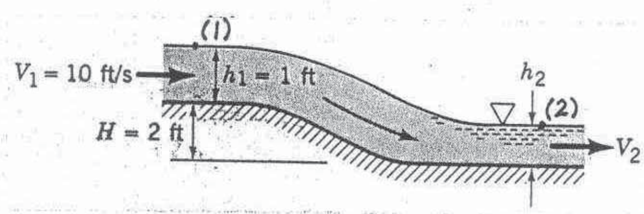

FIGURE P3.112

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 \qquad (1)$$

where $p_1 = 0$, $p_2 = 0$, $z_1 = 3\text{ ft}$, and $z_2 = h_2$

Also, $A_1 V_1 = A_2 V_2$

or

$$V_2 = \frac{h_1}{h_2} V_1 = \frac{(1\text{ft})(10\frac{\text{ft}}{\text{s}})}{h_2} = \frac{10}{h_2}$$

Thus, Eq. (1) becomes

$$\frac{(10\frac{\text{ft}}{\text{s}})^2}{2(32.2\frac{\text{ft}}{\text{s}^2})} + 3\text{ ft} = \frac{\left(\frac{10}{h_2}\right)^2}{2(32.2\frac{\text{ft}}{\text{s}^2})} + h_2$$

or

$$64.4 h_2^3 - 293 h_2^2 + 100 = 0$$

By using a root finding program the three roots to this cubic equation are found to be:

$h_2 = 0.630$ ft

$h_2 = 4.48$ ft

or

$h_2 =$ a negative root

Clearly it is not possible (physically) to have $h_2 < 0$. Thus, $h_2 = 0.630$ ft or $h_2 = 4.48$ ft