3.111

3.111 The flowrate in a water channel is sometimes determined by use of a device called a Venturi flume. As shown in Fig. P3.111, this device consists simply of a hump on the bottom of the channel. If the water surface dips a distance of 0.07 m for the conditions shown, what is the flowrate per width of the channel? Assume the velocity is uniform and viscous effects are negligible.

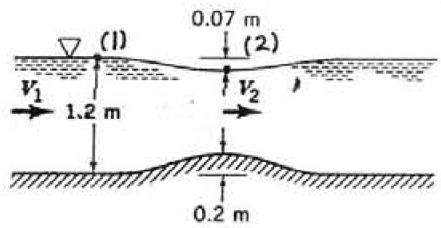

FIGURE P3.111

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

with $p_1 = 0$, $p_2 = 0$, $z_1 = 1.2\,m$, and $z_2 = 1.2\,m - 0.07\,m = 1.13\,m$

Also, $A_1 V_1 = A_2 V_2$

or

$$V_2 = \frac{h_1}{h_2} V_1 = \frac{1.2\,m \quad V_1}{(1.2 - 0.07 - 0.2)\,m} = 1.29\, V_1$$

Thus, from Eq. (1):

$$\frac{V_1^2}{2g} + z_1 = \frac{V_2^2}{2g} + z_2 \qquad \text{or } \left[(1.29)^2 - 1\right] V_1^2 = 2\left(9.81\,\frac{m}{s^2}\right)(1.2 - 1.13)\,m$$

or $V_1 = 1.438\,\frac{m}{s}$

Hence,

$$q = h_1 V_1 = \left(1.438\,\frac{m}{s}\right)(1.2\,m) = \underline{\underline{1.73\,\frac{m^2}{s}}}$$