3.58 The water tank in Fig. P3.58 stands on a frictionless cart and feeds a jet of diameter 4 cm and velocity 8 m/s, which is deflected 60° by a vane. Compute the tension in the supporting cable.

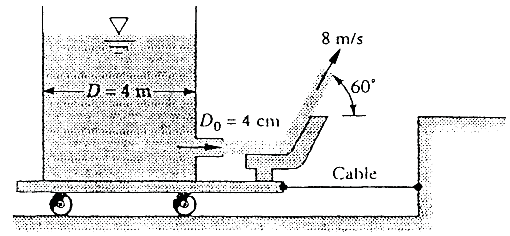

Fig. P3.58

Solution: The CV should surround the tank and wheels and cut through the cable and the exit water jet. Then the horizontal force balance is

$$\sum F_x = T_{cable} = \dot{m}_{out}u_{out} = (\rho A V_j)V_j\cos\theta = 998\left(\frac{\pi}{4}\right)(0.04)^2(8)^2\cos 60° = \mathbf{40\ N} \quad \textit{Ans.}$$

3.59 A pipe flow expands from (1) to (2), causing eddies as shown. Using the given CV and assuming p = p1 on the corner annular ring, show that the downstream pressure is given by, neglecting wall friction,

$$p_2 = p_1 + \rho V_1^2\left(\frac{A_1}{A_2}\right)\left(1 - \frac{A_1}{A_2}\right)$$

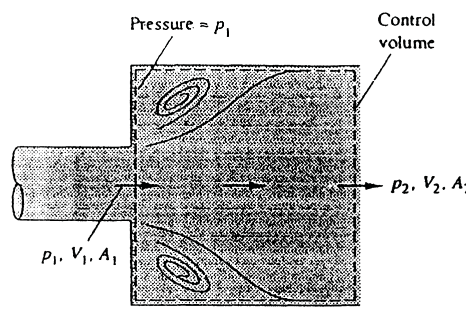

Fig. P3.59

Solution: From mass conservation, $V_1A_1 = V_2A_2$. The balance of x-forces gives

$$\sum F_x = p_1A_1 + p_{wall}(A_2 - A_1) - p_2A_2 = \dot{m}(V_2 - V_1), \quad \text{where } \dot{m} = \rho A_1V_1, \quad V_2 = V_1A_1/A_2$$

If $p_{wall} = p_1$ as given, this reduces to $\mathbf{p_2 = p_1 + \rho\frac{A_1}{A_2}V_1^2\left(1 - \frac{A_1}{A_2}\right)}$ *Ans.*

3.60 Water at 20°C flows through the elbow in Fig. P3.60 and exits to the atmosphere. The pipe diameter is $D1$ = 10 cm, while $D2$ = 3 cm. At a weight flow rate of 150 N/s, the pressure $p1$ = 2.3 atm (gage). Neglect-ing the weight of water and elbow, estimate the force on the flange bolts at section 1.

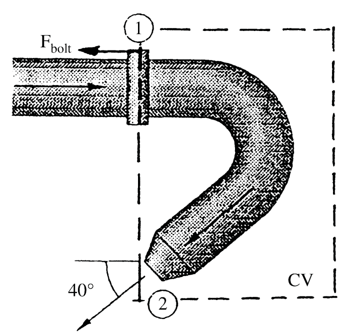

Fig. P3.60