Example 4A-10_5: Pressure Flow Problem 2

Determine the diameter pipe needed to prevent water from backing up during a major storm event.

Given:

Discharge, Q = 50 ft^3/s.

Pipe length = 300 ft.

Water Surface Elevation in upstream pipe = 17 ft.

Water Surface Elevation (high water) of stream = 16 ft.

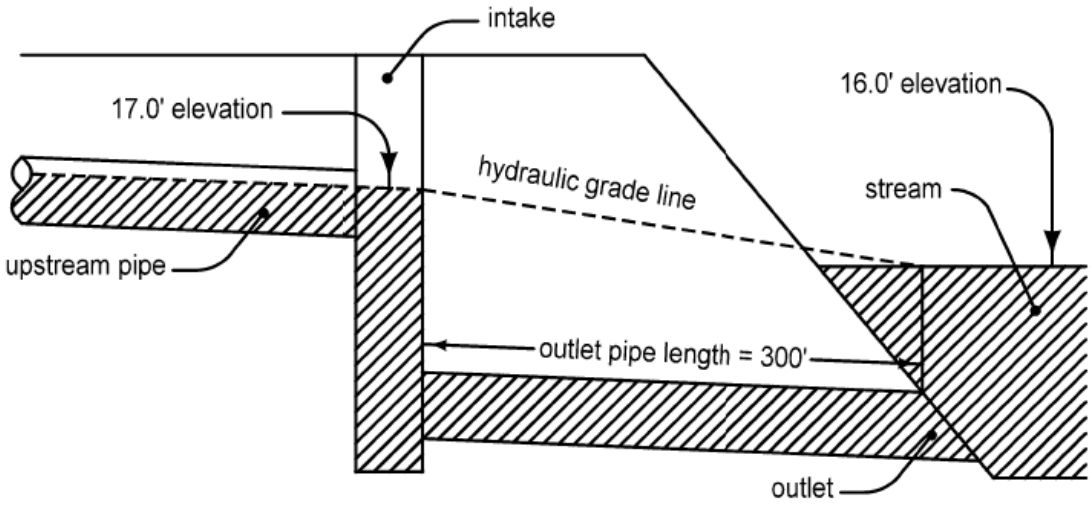

Figure 1: Storm sewer pipe with outlet submerged.

Solution:

1. Find the hydraulic gradient of outlet pipe (assume pressure flow in all parts of the outlet pipe):

$$\text{Hydraulic Gradient} = \frac{\begin{pmatrix}\text{elevation of}\\ \text{water in}\\ \text{upstream pipe}\end{pmatrix} - \begin{pmatrix}\text{downstream}\\ \text{water surface}\\ \text{elevation}\end{pmatrix}}{\text{length between elevation locations}} = \frac{17-16}{300} = 0.33\%.$$

2. Using the hydraulic gradient as the slope, determine a pipe diameter (D) that can drain 50 ft^3/s:

$$50\ ft^3/s = \pi\left(\frac{K_u}{n}\right)\left(\frac{D^{2.67}}{4^{1.67}}\right)\sqrt{S}, \text{ from which D = 3.3 ft (39.6 in).}$$

Use a 42-inch diameter pipe.

Check that the velocity (V) is within limits for D = 42 inches:

$$V = \left(\frac{K_c}{n}\right)\left(\frac{D}{4}\right)^{0.67}\sqrt{S} = \left(\frac{1.49}{0.013}\right)\left(\frac{3.5}{4}\right)^{0.67}\sqrt{.0033} = 6.0 \text{ ft/s.}$$

This is between 3 ft/s and 15 ft/s, so the velocity is acceptable.