## Test Format and Instructions

- 2 problems on 2 pages, 100 points
- closed book, w/ 3 pages of hand-written notes allowed
- initial all pages, staple solutions to test and hand in package
- start at 10:00, end at 11:00, Monday, April 26, 1999

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### 1. Open Channel Flow in Circular Pipes (30 points)

Given: A **24" diameter** concrete (n=0.013) storm sewer pipe must carry **3 ft$^3$/s** at a minimum velocity of **2.5 ft/s**.

Find: Minimum slope ($S_o$), water depth (d), flow when pipe is full ($Q_{full}$).

Note: If you use the hydraulic elements chart to solve this problem, write down the values that you use when entering the chart (e.g. d/D = ???), and the values you get from the chart (e.g. $R/R_{full}$ = ???)

$S_o = 1.5 \times 10^{-3}$
d = .84 ft.
$Q_{full}$ = 8.82 cfs

### 2. Open Channel Flow in Rectangular Channels (70 pts.)

Given: A rectangular concrete (n=0.013) is 10 ft wide and is laid on a slope of 0.1%. The flow in the channel is 50 cfs, and the water depth at the entrance of the channel is 0.7 ft. Answer the following questions.

a) What is the Froude number for the flow at the entrance of the channel, and what type of flow is this (i.e., subcritical or supercritcal)?

F = 1.5, supercritical

b) What is the critical depth ($d_c$) for a flow of 50 cfs in this channel?

$d_c$ = .919 ft.

c) What is the critical slope ($S_c$) for the flow of 50 cfs?

$S_c = 3.1 \times 10^{-3}$

d) Is the given channel ($S_0$ = .1 %), mild or steep? Would you expect a hydraulic jump in this channel, assuming uniform flow downstream?

Mild, yes

e) Assume the flow in the rectangular channel is wide and shallow. Using this assumption, write an equation that gives the flow in the channel per unit width (q), as a function of Manning's n, water depth (d), and bed slope ($S_o$).

f) Assuming again that the flow in the rectangular channel is wide and shallow, write an equation for the Froude number ($N_f$) as a function of q, n, g (gravity), and $S_o$. Hint: Use the equation developed in d).