BRANCH-NETWORK FLOW MODEL

The U.S. Geological Survey BRANCH model, used to calculate flow in the study area, is a one-dimensional, unsteady-flow computer model (Schaffranek and others, 1981). The BRANCH model solves the one-dimensional equations of continuity and motion:

$$B(\partial z/\partial t) + (\partial Q/\partial x) - q = 0 \ , \qquad (1)$$

$$(\partial Q/\partial t) + [\partial(\beta Q^2/A)/\partial x] + gA(\partial z/\partial x) + (gk/AR^{4/3})\ Q\ |Q|$$

$$-\varepsilon B U_\sigma^2 \cos\sigma = 0 \ . \qquad (2)$$

where: B = channel top width, in feet;
z = water-surface elevations, in feet;
t = time step, in seconds;
Q = discharge, in cubic feet per second;
x = longitudinal distance along the channel, in feet;
q = lateral inflow, in feet per second;
A = cross-sectional area, in square feet;
g = gravitational acceleration, in feet per second per second;
k = flow-resistance coefficient;
R = hydraulic radius, in feet; and,
U_σ = wind velocity occurring at an angle σ, in feet per second.

The coefficient β, known as the momentum or Boussinesq coefficient, is expressed as:

$$\beta = \quad u^2 dA/U^2 A \ , \qquad (3)$$

and is used to adjust for any nonuniform velocity over the channel cross section. In this coefficient, u represents the velocity of water passing through a finite elemental area, dA, and U is the mean flow velocity in the entire cross-sectional area, A.

The coefficient ε is the dimensionless wind-resistance coefficient which can be expressed as:

$$\varepsilon = C_d(\rho_a/\rho) \ , \qquad (4)$$

in which C_d is the water-surface drag coefficient, ρ_a is the atmospheric density, and ρ is the water density.

In derivation of equations (1) and (2), it is assumed that the flow is essentially homogeneous in density and that hydrostatic pressure is present at any point in the channel. The channel is assumed to be reasonably straight, the geometry simple, and the gradient mild and uniform. The frictional resistance is assumed to be approximated by the Manning formula. Approximate solutions can be obtained for the nonlinear partial-differential equations by finite difference techniques.