# Contaminant Transport in Municipal Water Systems

## Submitted by: Charles Howard and Associates Limited

The problem is to determine water quality in a water distribution network as a function of time and location. The mathematical problem can be visualized (vaguely) as a system of equations that describe the spatial and temporal transport and dilution of a contaminant injected at a specific location.

Municipal water distribution systems are unsteady flow, nonlinear networks. In general, the unknowns are: the pressures (after eliminating elevation differences) at each node, the consumption at each node, and the frictional characteristics of each link. The flow in a link is a derived variable that depends on the difference in pressure across the link and the frictional characteristic of the link. In special cases some of the unknowns are known from field measurements, but in general the number of unknowns exceeds the number of equations that can be written (one equation of flow continuity for each node). In practice measurements are expensive so many of the unknowns are assumed to be known.

The main interest of the company is to determine the distribution of the contaminant volume, ie, its mass and concentration, as a function of time - who gets to drink it, for how long, and when. It is desirable to develop first, a closed form mathematical solution for an approximation to the real problem, and second, a numerical method that could be used to determine the range of applicability of the mathematical method. Then use the mathematical method to solve the inverse problem - given time varying measurements (of concentration and some of the pressures) determine the likely source(s) of the contaminant.