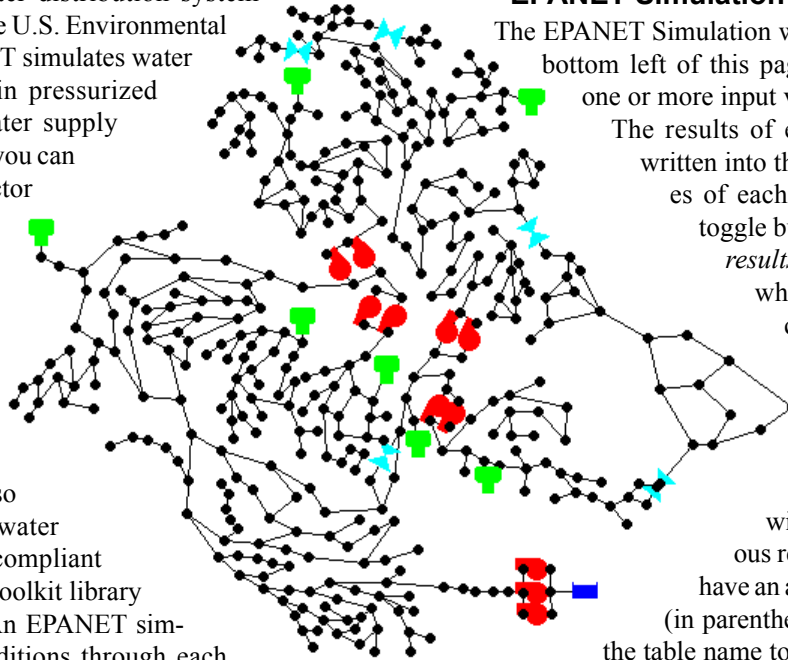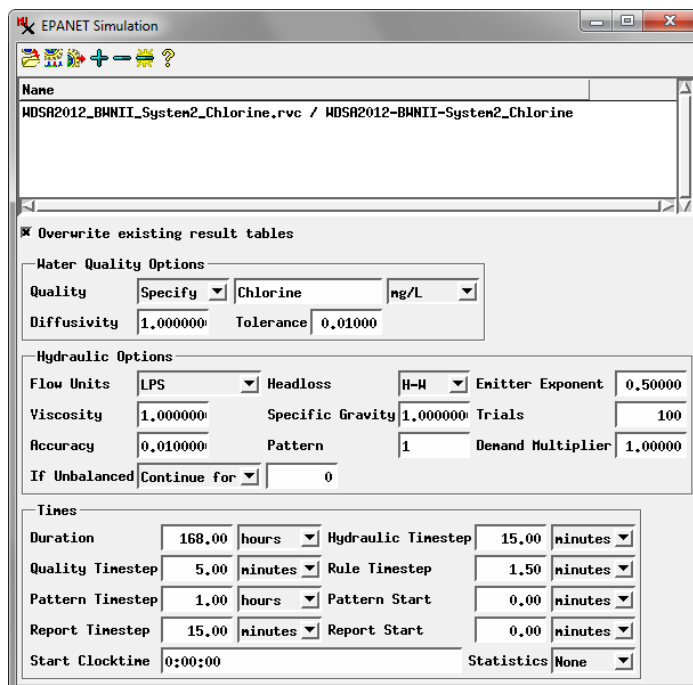# Run EPANET Pipe Network Simulations

EPANET is a public-domain water distribution system modeling program developed by the U.S. Environmental Protection Agency (EPA). EPANET simulates water flow and water quality changes in pressurized pipe networks, such as a city water supply system. In TNTmips and TNTedit you can create, edit, import, and export vector objects representing pipe networks with attributes that conform to the EPANET data model (see the Technical Guide entitled *Import-Export: EPANET Pipe Networks in TNTmips*).

The EPANET Simulation process in TNTmips (Geometric / Spatial Analysis / EPANET Simulation) also lets you compute hydraulic and water quality simulations on EPANET-compliant vector objects using the EPANET toolkit library that is installed with TNTmips. An EPANET simulation tracks the water flow conditions through each network link (pipe, valve, or pump) and node (junction, tank, or reservoir) through a series of time steps. The changing concentration of a chemical species can also be tracked. The conditions at each time step are recorded in Simulation Results tables that are added to the pipe network vector object, with a record for each time step that is attached to the relevant line or node element.

EPANET Simulation Window

The EPANET Simulation window (illustrated at the bottom left of this page) allows you to select one or more input vector objects to process. The results of each simulation run are written into the line and node databases of each input vector object. A toggle button (*Overwrite existing results tables*) lets you choose whether or not to have the current results overwrite the Simulation Results tables from the previous simulation. If this toggle is turned off, new tables are added without deleting the previous results, and the new tables have an auto-incremented number (in parentheses) added to the end of the table name to indicate the order of the results.

The lower part of the EPANET Simulation window includes sections for setting water quality, hydraulic, and time options for the current simulation run (see below). Default values for the processing parameters are read from the first vector object selected, but you can change any of the parameters before running the simulation. The same set of parameters is applied to all of the input vector objects and all parameters are saved with those objects to provide default values for later sessions.

You can run an EPANET simulation interactively by pressing the Run button or in the background via the TNTmips Job Processing System by pressing the Queue Job or Save Job icon buttons (see the TechGuide entitled *System: TNTmips Job Processing System*).

Simulation Parameters

An EPANET simulation always computes changing hydraulic states through time. The Hydraulic Options section of the EPANET Simulation window lets you set parameters such as the flow units to use and the fluid viscosity and specific gravity. A water quality analysis is optional; to omit the quality analysis, choose None from the Quality menu in the Water Quality Options. A complete explanation of the Water Quality and Hydraulic Options can be found in the EPANET 2 Users Manual (Options, pages 152-154), which can be accessed by pressing the EPANET Documentation icon button on the toolbar.

The Times section on the EPANET Simulation window lets you set the duration of the simulation and the timestep intervals for various aspects of the simulation. These parameters are also explained in detail in the EPANET 2 Users Manual (Times, pages 173-174).

Save Job — Queue Job — Run — Add — Remove Selected — Remove All — EPANET Documentation

Running a Simulation

When the simulation is run, the process transfers the characteristics of your pipe network and the processing parameters you have set to an EPANET "Input" file (a formatted text file). This file is passed to the EPANET toolkit library, which performs the timestep simulation. TNTmips retrieves the simulation results and writes them back to the node and line databases of the input vector object(s). The input file is saved with a .inp file extension, along with a text report file (with a .txt file extension). When you run the simulation (or designate it for job processing) you are prompted to provide names for these output files.

The report file can include a summary, a report of average energy usage by each pump, and a detailed status section that identifies all network components that change status during each time step. It can also include reports for individual nodes and links in the network. The contents of the text report file can be specified by editing the records in the Report table in the Nodes database; see the pages 161 to 162 of the EPANET 2 User Manual for the format and options. The summary section of a sample report file is shown below.

```
Page 1                              Thu Sep 12 17:09:14 2013

  ******************************************************************
  *                        E P A N E T                            *
  *               Hydraulic and Water Quality                     *
  *                Analysis for Pipe Networks                     *
  *                    Version 2.00.12                            *
  ******************************************************************

  BWNII

      Input Data File ......... E:\EPANET\Simulations\BWNII.inp
      Number of Junctions................ 399
      Number of Reservoirs............... 1
      Number of Tanks ................... 7
      Number of Pipes ................... 443
      Number of Pumps ................... 11
      Number of Valves .................. 5
      Headloss Formula .................. Hazen-Williams
      Hydraulic Timestep ................ 15.00 min
      Hydraulic Accuracy ................ 0.010000
      Status Check Frequency ............ 2
      Maximum Trials Checked ............ 10
      Damping Limit Threshold ........... 0.000000
      Maximum Trials .................... 100
      Quality Analysis .................. Chlorine
      Water Quality Time Step ........... 5.00 min
      Water Quality Tolerance ........... 0.01 mg/L
      Specific Gravity .................. 1.00
      Relative Kinematic Viscosity ...... 1.00
      Relative Chemical Diffusivity ..... 1.00
      Demand Multiplier ................. 1.00
      Total Duration .................... 10080.00 min
      Reporting Criteria:
         Selected Nodes
         Selected Links

  Analysis begun Thu Sep 12 17:09:14 2013
```
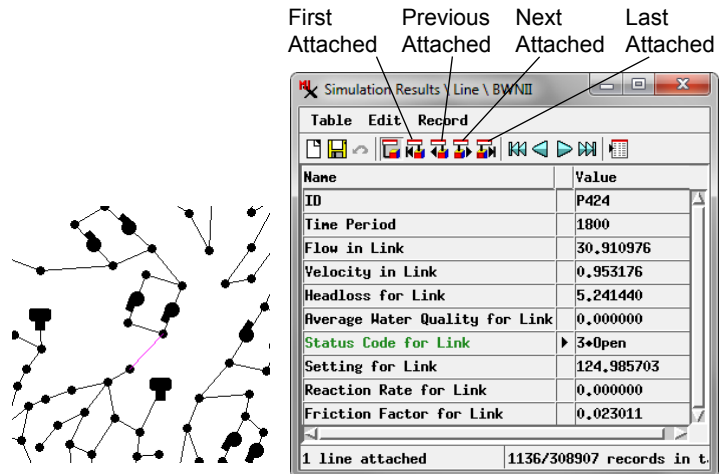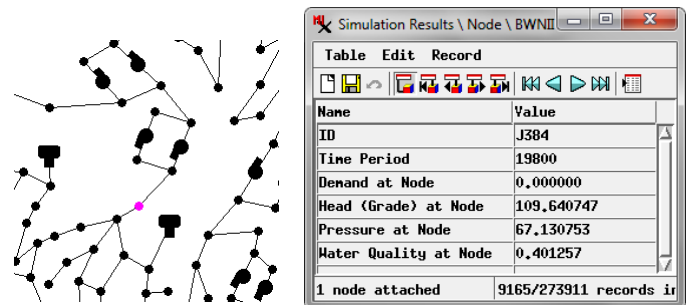
Simulation Results

The EPANET Simulation process records conditions at each time step for each element in the network. Simulation Results tables are created for both lines and nodes. The records in these tables record hydraulic and water quality (if specified) conditions at each time step for the attached network element. Each network element thus will have multiple attached records in the Simulation
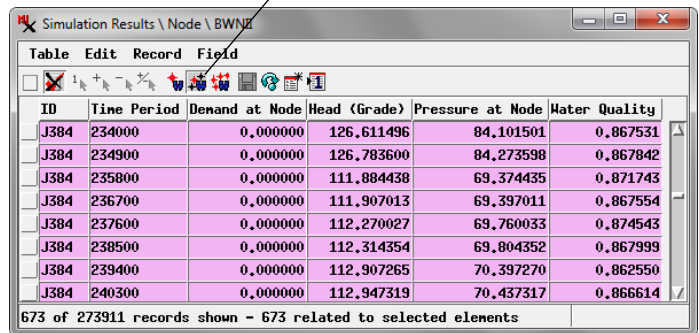
Results table. When you display the EPANET vector after running a simulation, you can view the records for a particular element marked in the View window in either single-record or tabular view of the table (chosen using options on the Table menu). In single-record view, icons at the top of the window allow you to step through the time-step records for the marked network element (see illustrations below). In tabular view, you can use the Show Marked Element Records button to restrict the listing to only the records attached to the selected element.

First Attached   Previous Attached   Next Attached   Last Attached

Single-record views of an attached record for a selected pipe element (above) and a selected pipe junction (below). Marked elements are shown in magenta in the network illustrations. Each element has one attached record reporting the results for a particular time step in the simulation (identified by the value in seconds in the Time Period field). In single-record view you can use the icon buttons at the top of the table window (labeled above) to step through the timestep records for a particular element

Show Marked Element Records

Tabular view of attached records for a selected pipe junction element.