Introduction to EPANET 2.0

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What Is EPANET

- Performs extended period simulation of hydraulic and water quality behavior within pressurized pipe networks.
  - Tracks water flow in each pipe, pressure at each node, height of water in each tank, and concentration of a chemical species throughout the network during a simulation period comprised of multiple time steps.
  - In addition to chemical species, water age and source tracing can also be simulated.
- Provides an integrated environment for editing network input data, running hydraulic and water quality simulations, and viewing the results in a variety of formats.
- Developed by the Water Supply and Water Resources Division (formerly the Drinking Water Research Division) of the U.S. Environmental Protection Agency's National Risk Management Research Laboratory.

EPANET Hydraulic Modeling Capabilities

- No limit on the size of network that can be modeled
- Computes friction head loss using either Hazen-Williams, Darcy-Weisbach, or Chezy-Manning equations
- Includes minor head losses for bends, fittings, etc.
- Models constant or variable speed pumps
- Computes pumping energy and cost
- Models various types of valves including shutoff, check, pressure regulating, and flow control valves
- Allows storage tanks to have any shape (i.e., diameter can vary with height)
- Considers multiple demand categories at nodes, each with its own pattern of time variation
- Models pressure-dependent flow issuing from emitters (sprinkler heads)
- Base system operation on both simple tank level or timer controls and on complex rule-based control

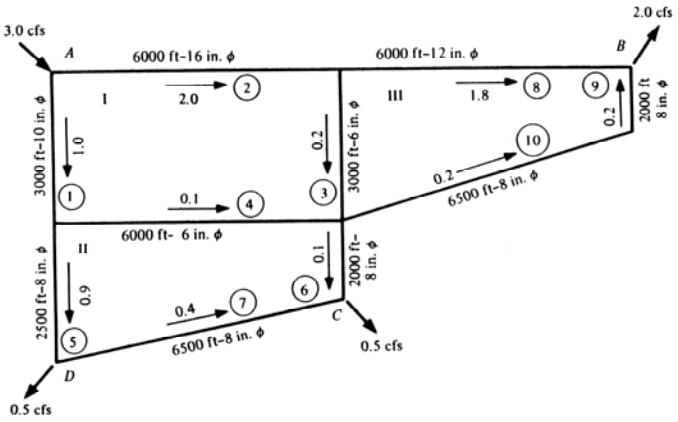
EPANET Operational Definitions

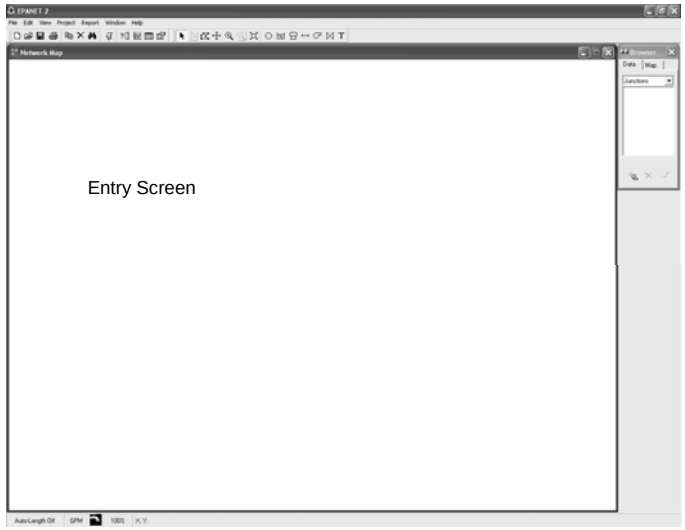
- EPANET models a water distribution system as a collection of links connected to nodes. The links represent pipes, pumps, and control valves. The nodes represent junctions, tanks, and reservoirs. The figure below illustrates how some of these objects can be connected to one another to form a network.
- Reservoir or Tank – installed above node with negative demand
- Pump – not shown
- Pipe – link between nodes
- Junction – also called a node

Steps for an EPANET Analysis

- One typically carries out the following steps when using EPANET to model a water distribution system:
  - Draw a network representation of your distribution system
  - Edit the properties of the objects that make up the system
  - Describe how the system is operated
  - Select a set of analysis options
  - Run a hydraulic/water quality analysis
  - View the results of the analysis.

EPANET Example

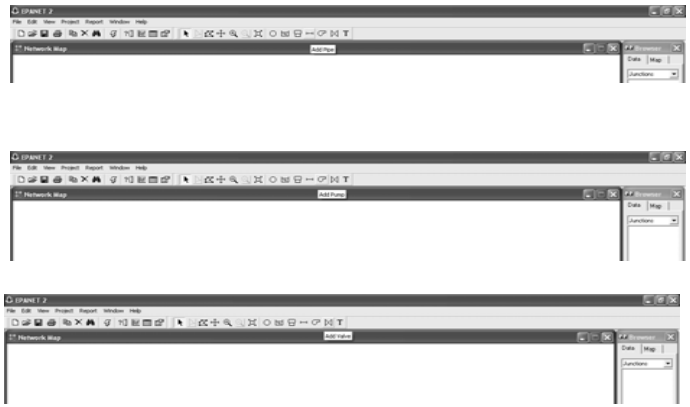




Entry Screen

Status Bar

- The Status Bar appears at the bottom of the EPANET workspace and is divided into four sections:
  - Flow Units - displays the current flow units that are in effect
  - Zoom Level - displays the current zoom in level for the map (100% is full scale)
  - Run Status - the faucet icon shows running water when results of an analysis are available
  - XY Location - displays coordinates of current map location



Creating a New Project

- **To create a new project:**

  1. Select **File | New** or click the **New Project** button on the General toolbar.

  2. You will be prompted to save the exiting project (if changes were made to it) before the new project is created.

  3. A new, unnamed project is created with all options set to their default values.

- A new project is automatically created whenever EPANET first begins and the screen looks like the one shown below.

Opening and Saving Existing Projects

- ***Opening an Existing Project***
- **To open an existing project stored on disk:**
- Either select **File | Open** or click the **File Open** button on the General toolbar. You will be prompted to save the current project (if changes were made to it). Select the file to open from the standard **Open File** dialog box.

- ***Saving a Project***
- **To save a project under its current name:**
- Either select **File | Save** or click the **Save** button on the General toolbar.
- **To save a project using a different name:**

  1. Select File | Save As.

  2. A standard **File Save As** dialog box will appear from which you can select the folder and name that the project should be saved under.

Setting Project Defaults

- **To set default values for a project:**
- Select **Project | Defaults**.
- A **Defaults** dialog form will appear with three pages of default categories which you can edit: Default ID Labels; Default Node/Link Properties; Default Hydraulic Options
- Check the box in the lower right of the dialog form if you want to save your choices for use in all new future projects as well.
- Click OK to accept your choice of defaults.

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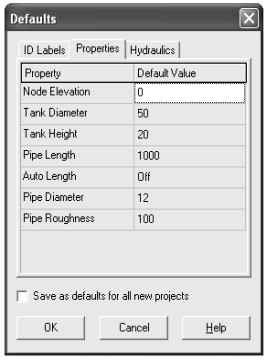

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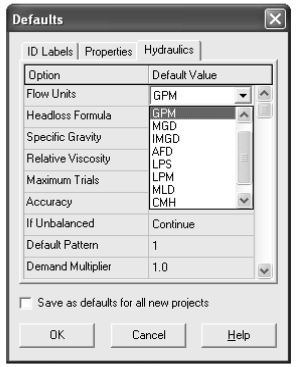

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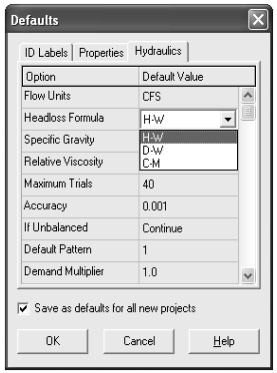


Adding an Object: Junctions

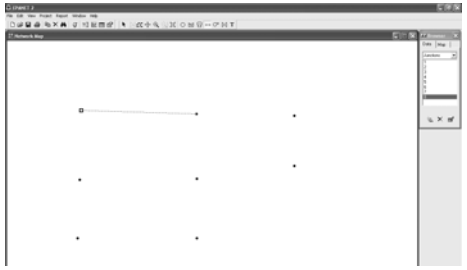
To add a Junction using the Map Toolbar:

- Select the type of junction (node, reservoir, or tank) to add from the Map toolbar. Move the mouse to the desired location on the map and click.

NOTE: As the junctions appear, the list appears in the browser window on the right.

Adding an Object: Links

- **To add a Link using the Map Toolbar:**
- Select the type of link to add (pipe, pump, or valve) from the Map Toolbar
- Click the mouse over the link's start node. The start node will flash and a pencil will appear on the screen.
- Move the pencil between the start and end nodes.
- Click the mouse again over the link's end node



NOTE: It appears to be a pencil drawing the link into the screen. The pencil goes away when the end node is clicked.

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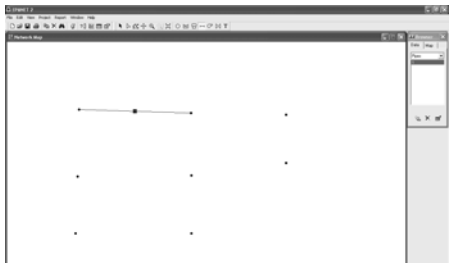
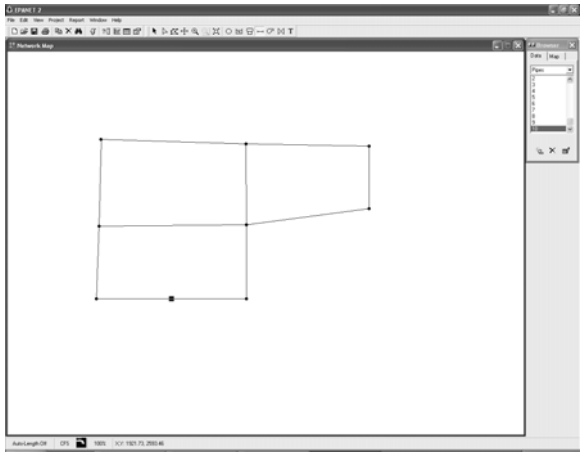


NOTE: When the link is in the system, the center square will flash.

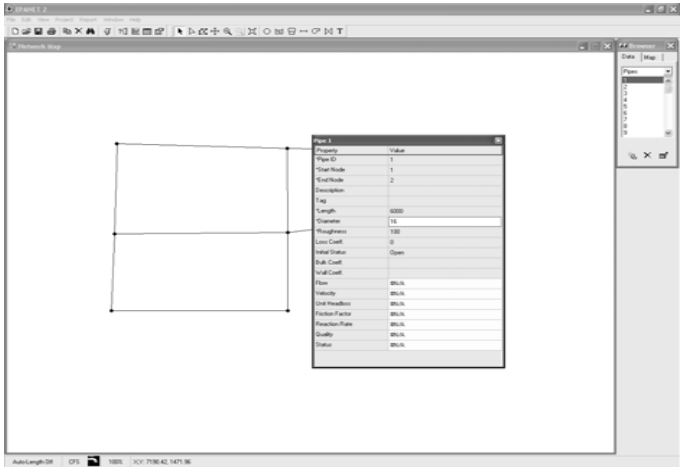
Completed Grid



Editing an Object
(Adding Information to Links and Junctions)

To edit an object appearing on the map

- Select the object on the map and double-click the object on the map. The appropriate table will appear.
- For junctions, minimum required information is demand and elevation.
- For pipes, minimum required information is start and end nodes, lengths, diameters, and roughness.
- For tanks, minimum required information is elevation, a diameter, a minimum, maximum and an initial water level.
- Items in yellow are not entered; they are calculated by EPANET during a simulation.



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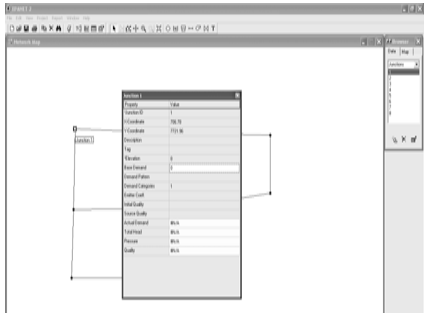
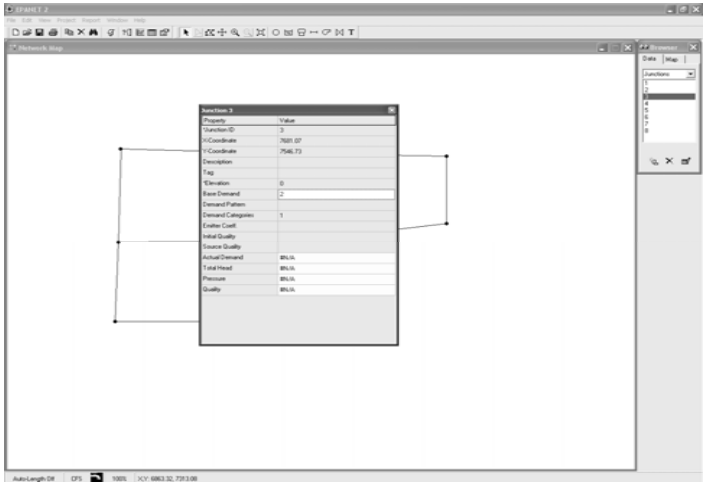
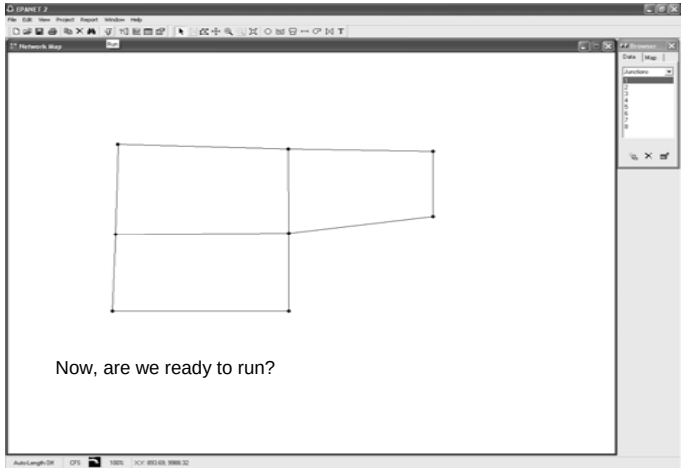
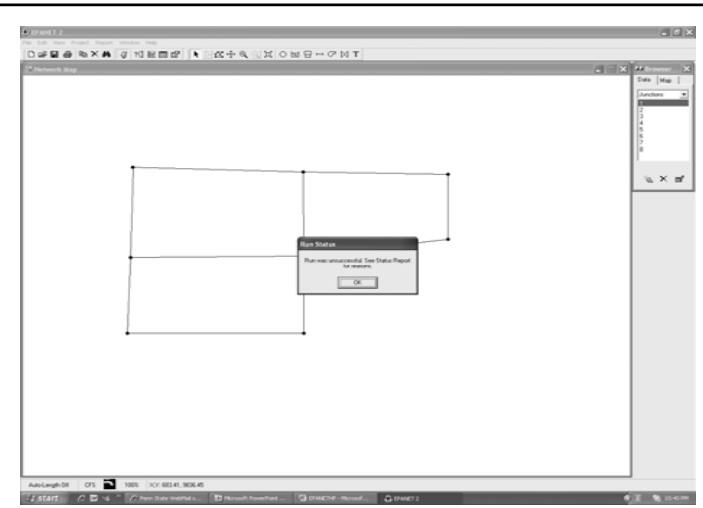
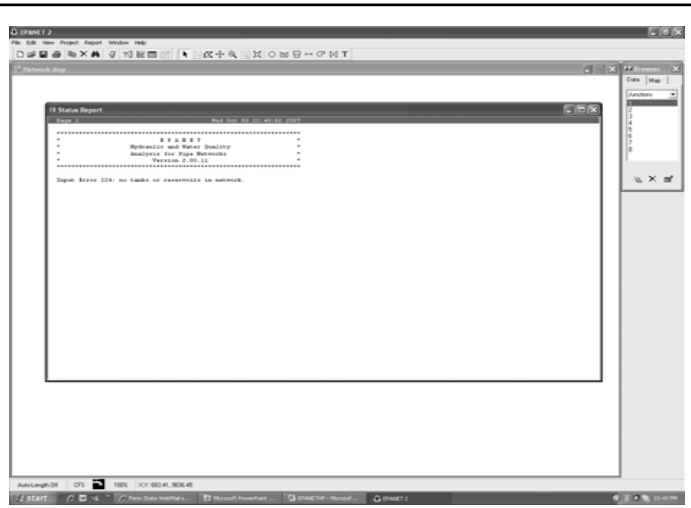






Now, are we ready to run?





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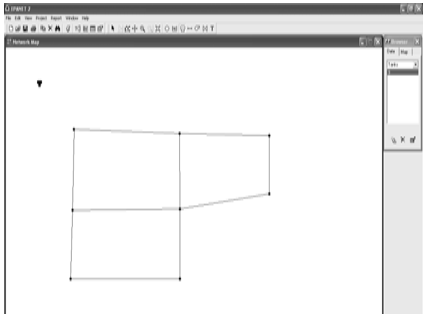

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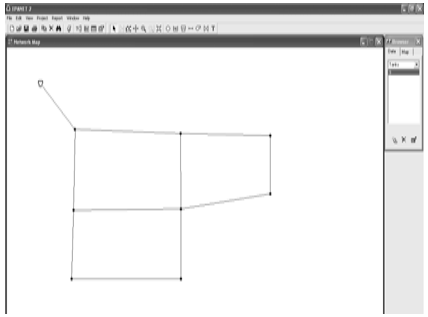

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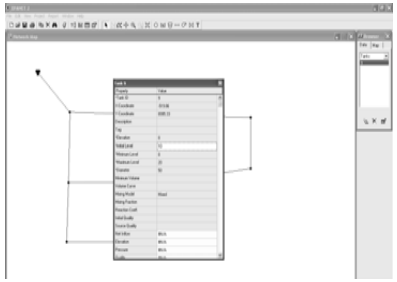

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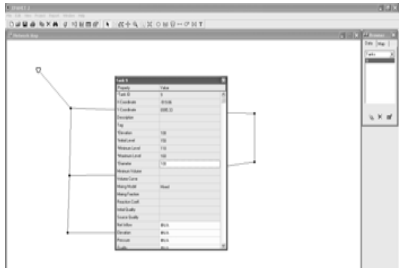
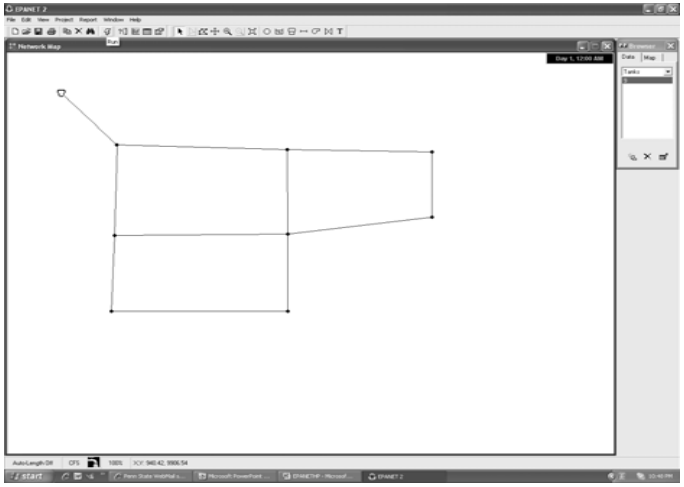
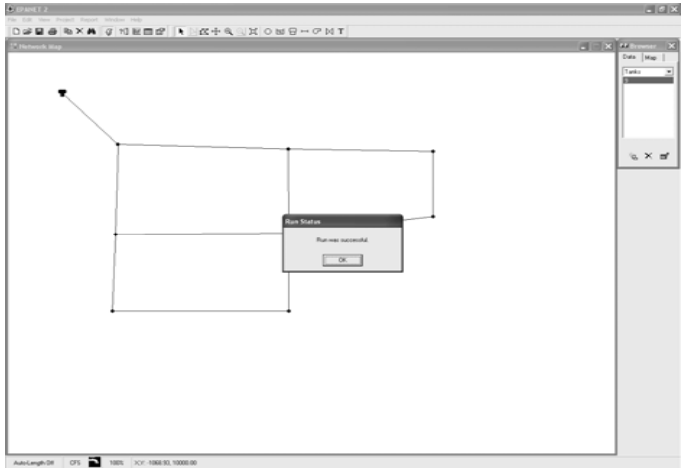




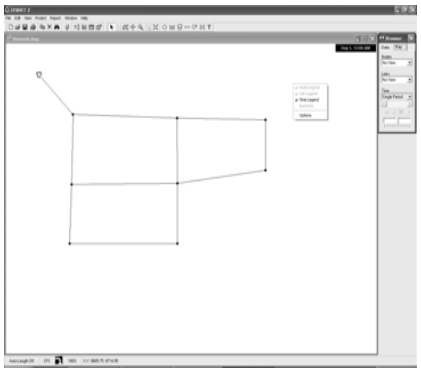


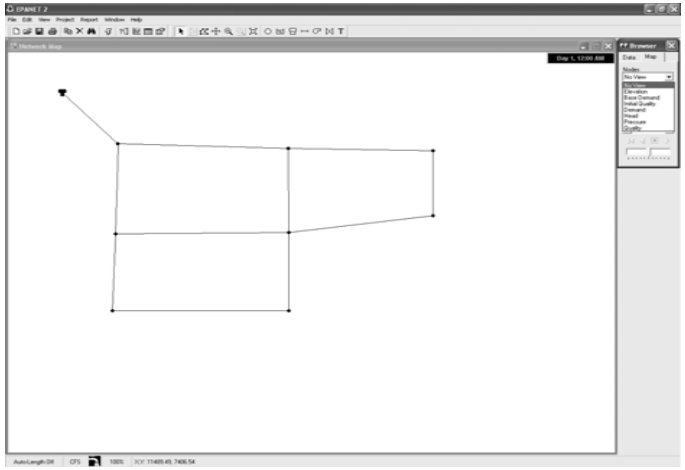
Now, to see the results…..

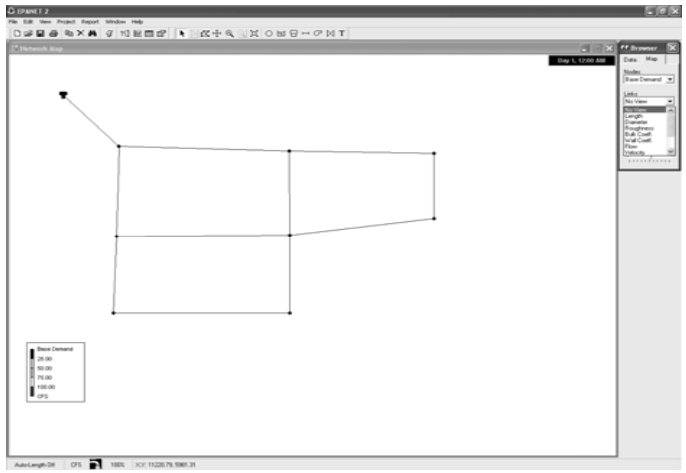
Changing Map Features

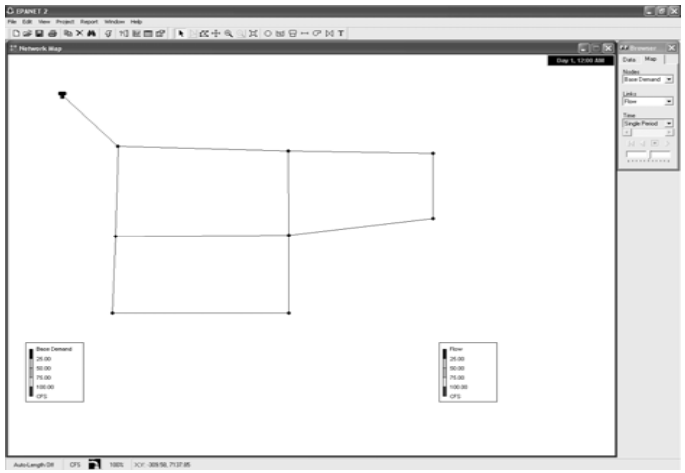
To add a label to the map:

- Select the **Label** button on the Map Toolbar.
- Click the mouse on the map where label should appear.
- Enter the text for the label.
- Press the **Enter** key.
- Or access the map features by clicking on the map, and then right-click with the mouse. When the pop-up menu appears, select **Options**. Edit the appropriate features as shown below.

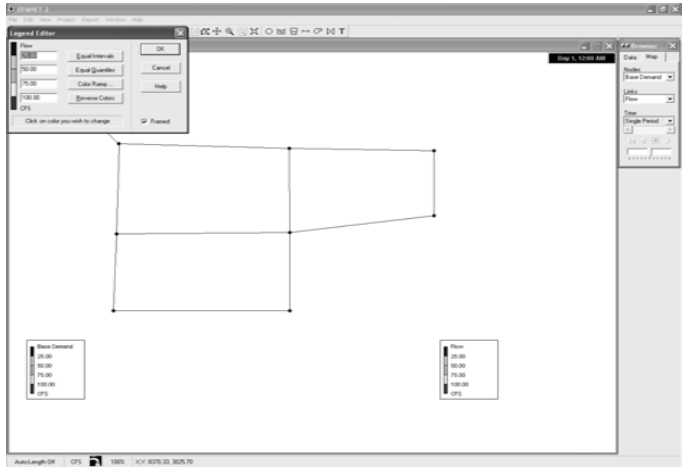




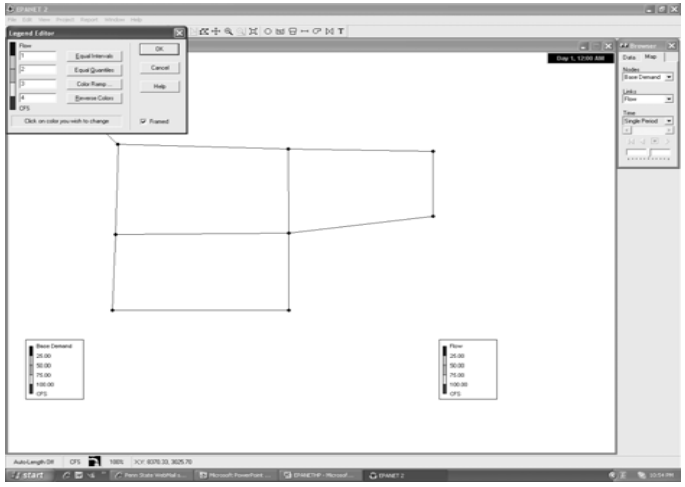


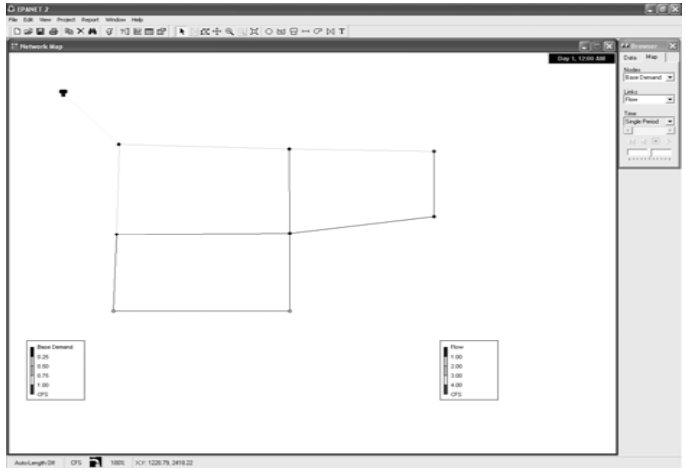


NOTE: Scale not in sufficient detail.

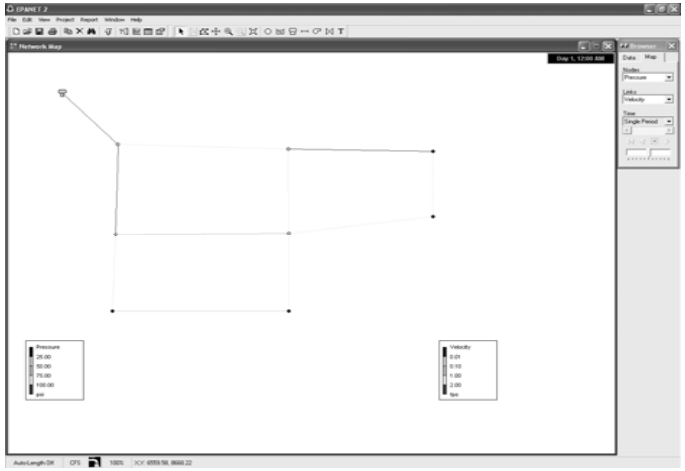


Right click on legend and popup box appears. Modify as needed.

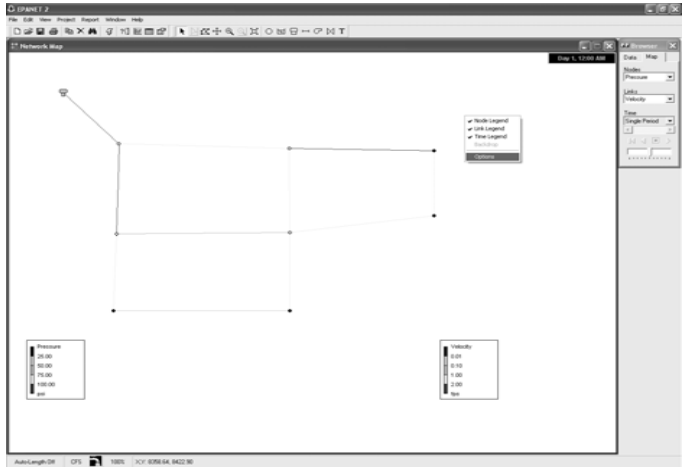




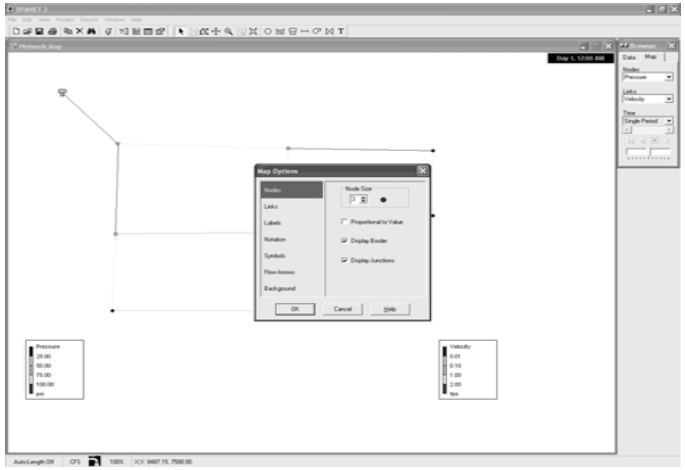
Are flow and demand the only requirements for system operation?

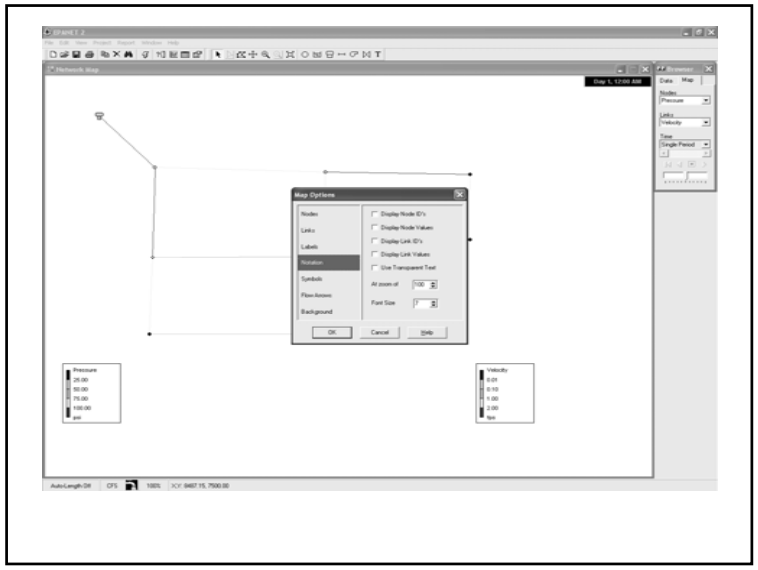


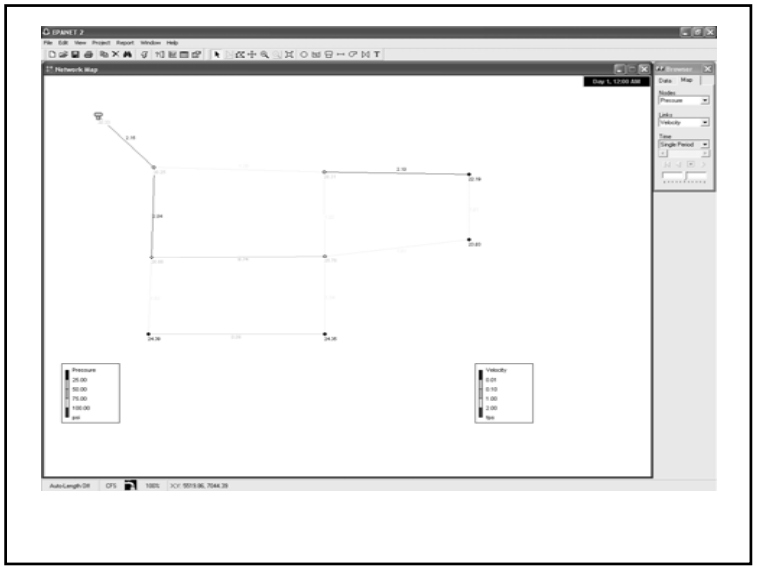
Does this design meet the requirements? If not, adjust until the design criteria is met.

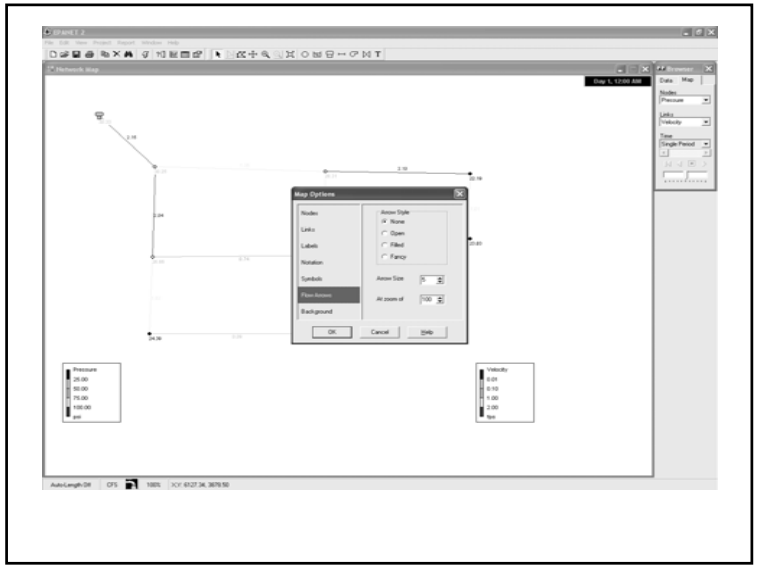


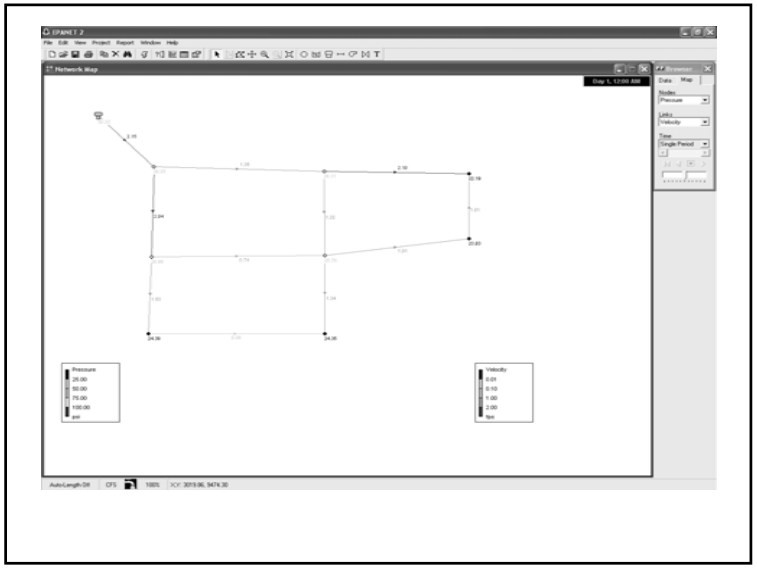
More information needed on map to see actual values rather than ranges?



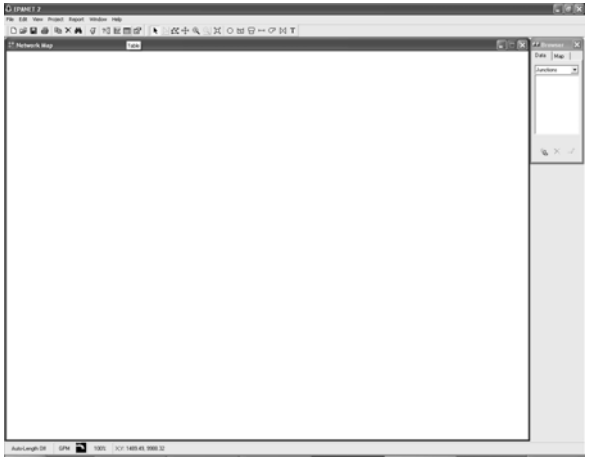


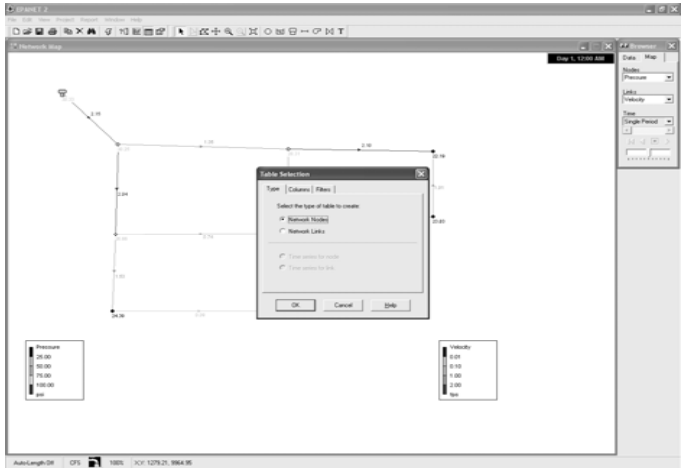


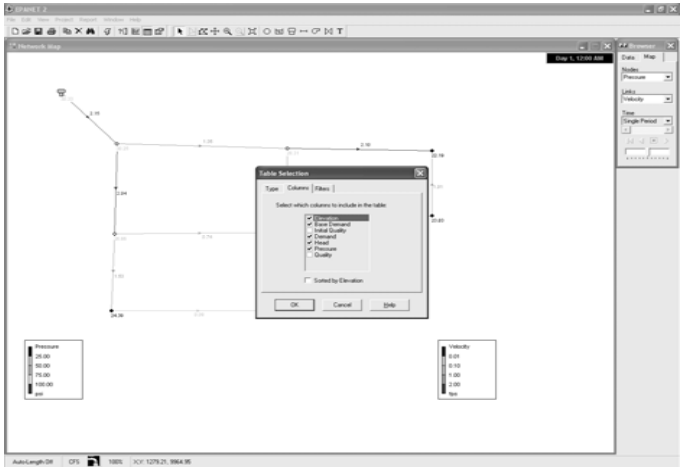


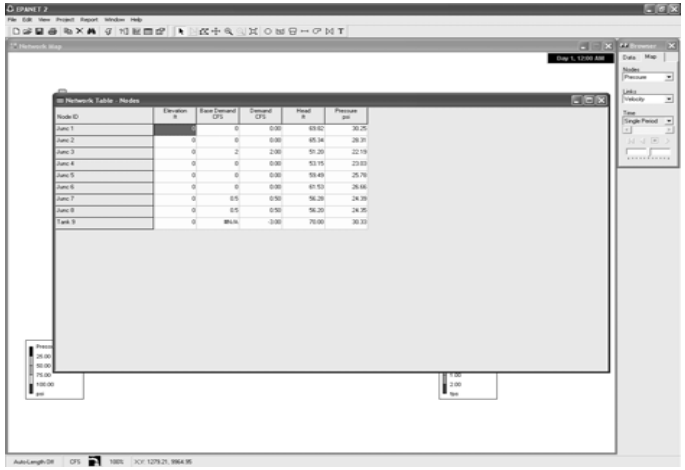


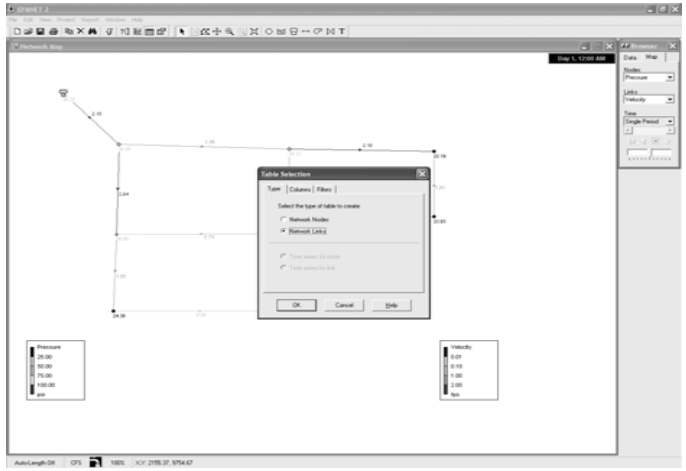
Viewing the Results

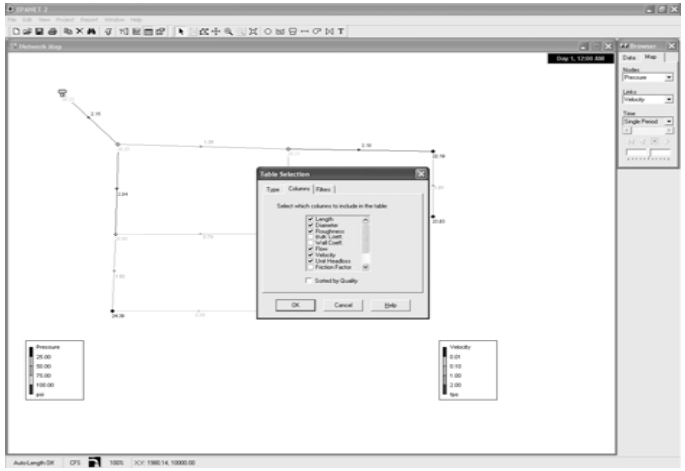


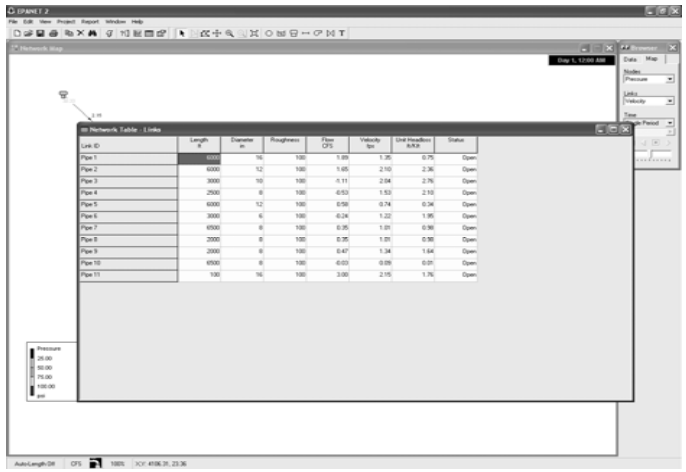












Demand Patterns

- The previous analysis assumed that there was a constant demand in the city, which is not accurate.
- It is possible to create a scenario where each hour is a multiplier from the minimum demand.
- For example, we could use average demand and put in the multipliers for the hours of the day (or ratio off maximum or minimum flows).
- One example is to do multipliers off minimum flow.

Table 2. Demand Multiplying factors.

Hour	1	2	3	4	5	6	7	8	9	10	11	12
Factor	1	2	2	5	8	10	15	17	24	20	16	14

Hour	13	14	15	16	17	18	19	20	21	22	23	24
Factor	10	8	15	20	16	8	5	4	2	2	1.5	1

Creating a New Demand Pattern

- To create a new demand pattern:
  1. Click on Add button from the Patterns Editor of the Database Browser.
  2. In the pattern editor window, fill in the description and multipliers for each hour of the day.
  3. Save the pattern
  4. Click OK to accept the pattern

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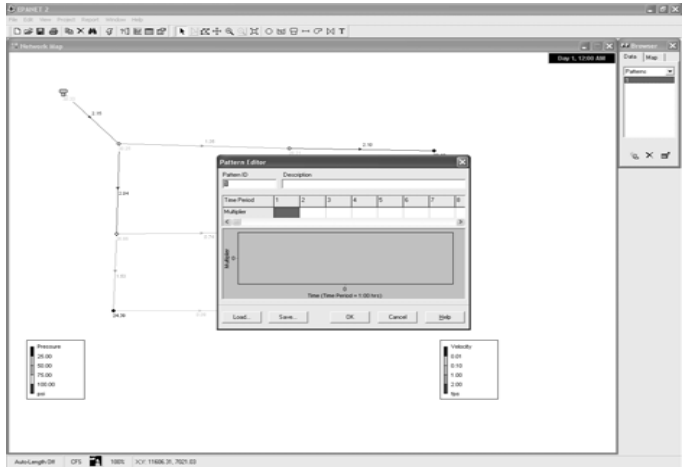
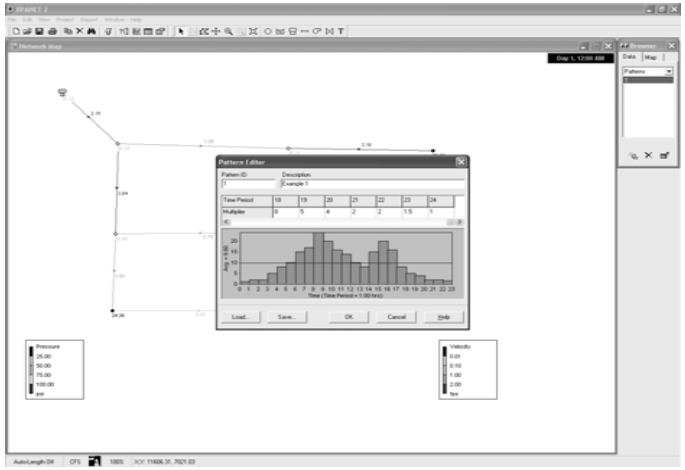
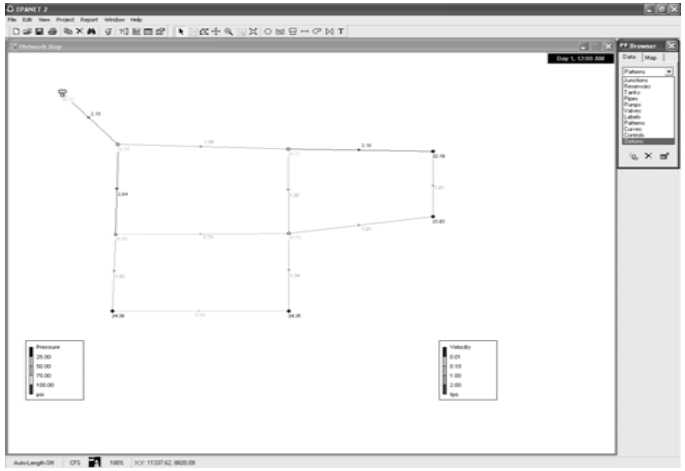


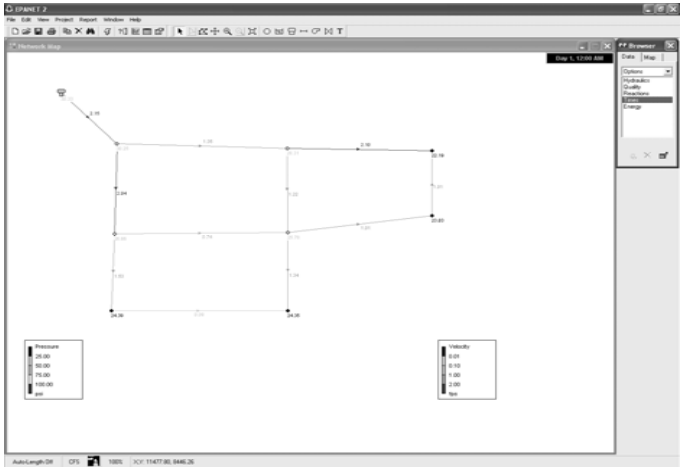


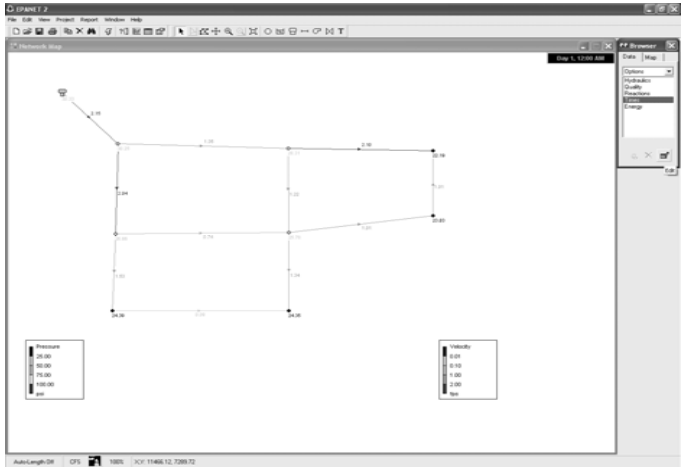
Creating a Time Series Analysis

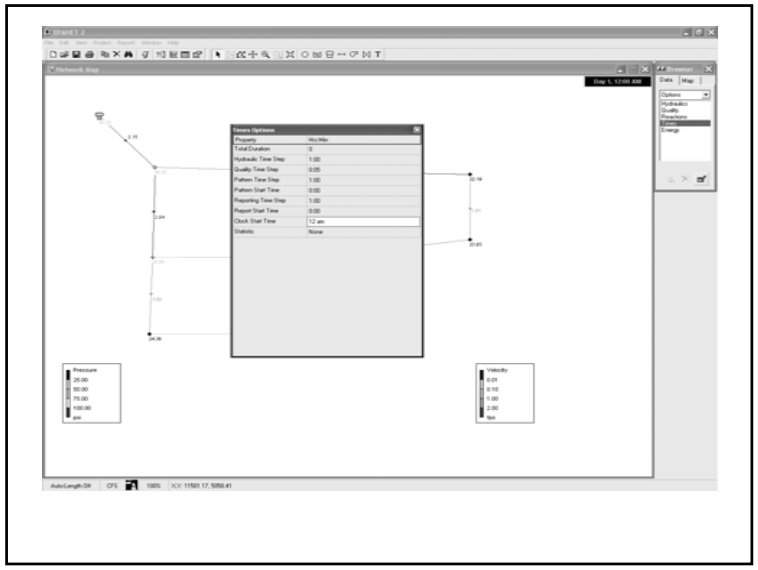
1. Select Options from the Object list of the Database Browser.
2. Select Times from the Item list.
3. If the Property Editor is not already visible, click the Edit button.
4. Select a total duration of 24 hours for the simulation. Close the times options window.
5. Save the project and Run the program again.

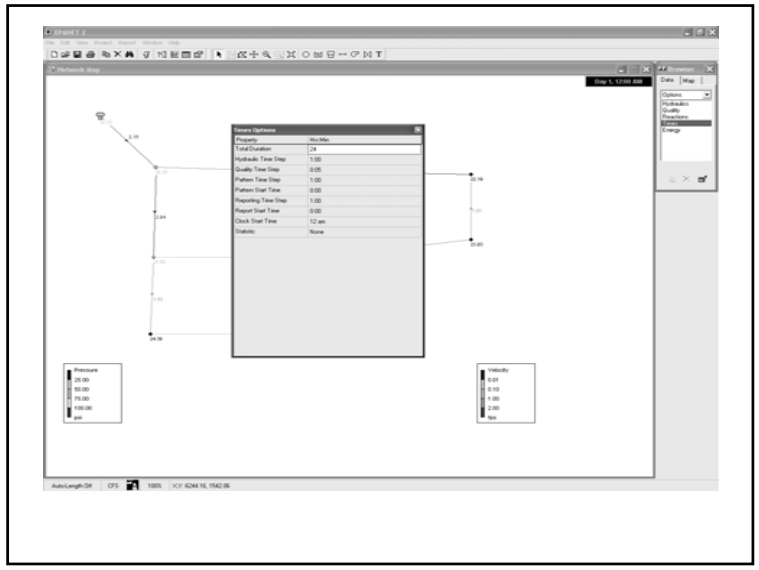
- Once the time series is created, it is possible to observe the simulation for different periods of the day.

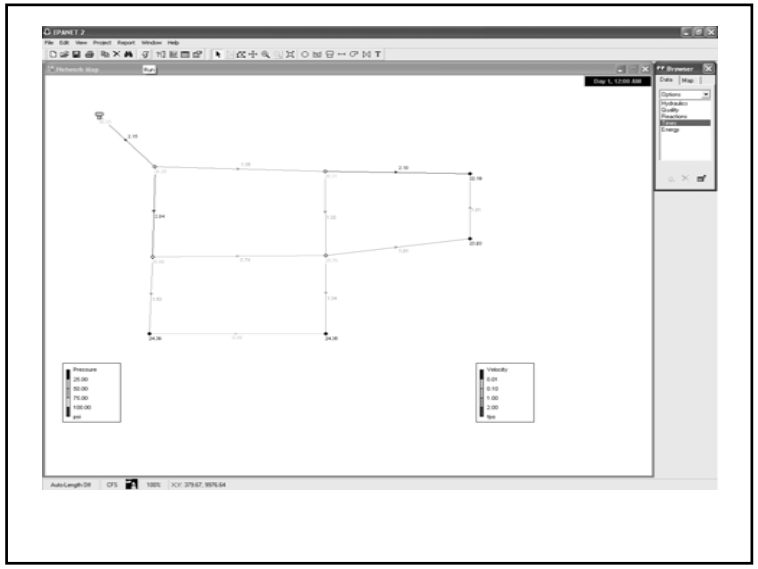


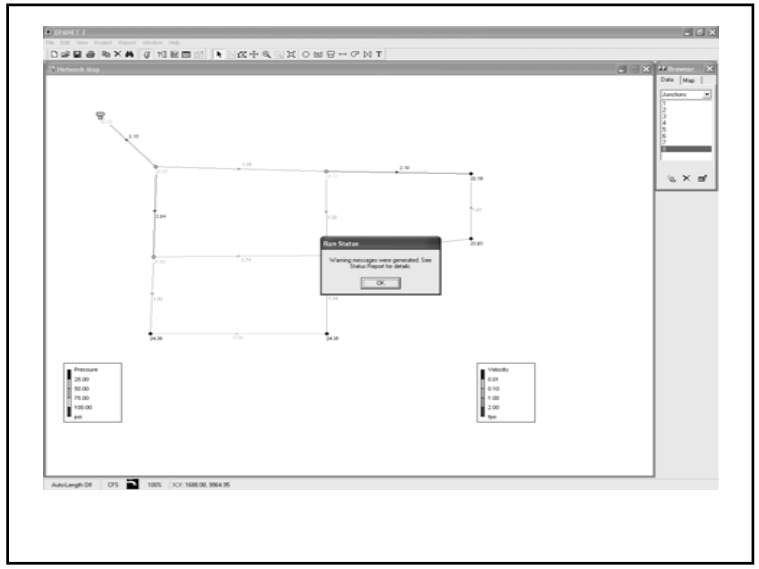


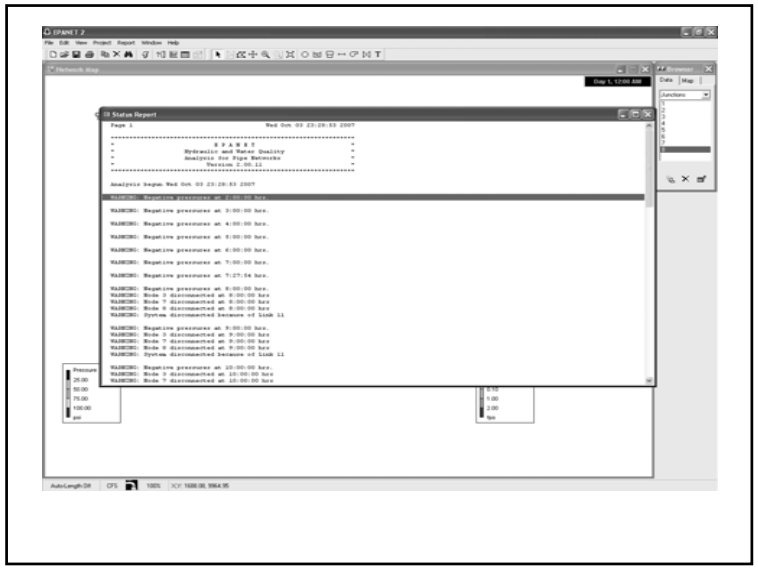


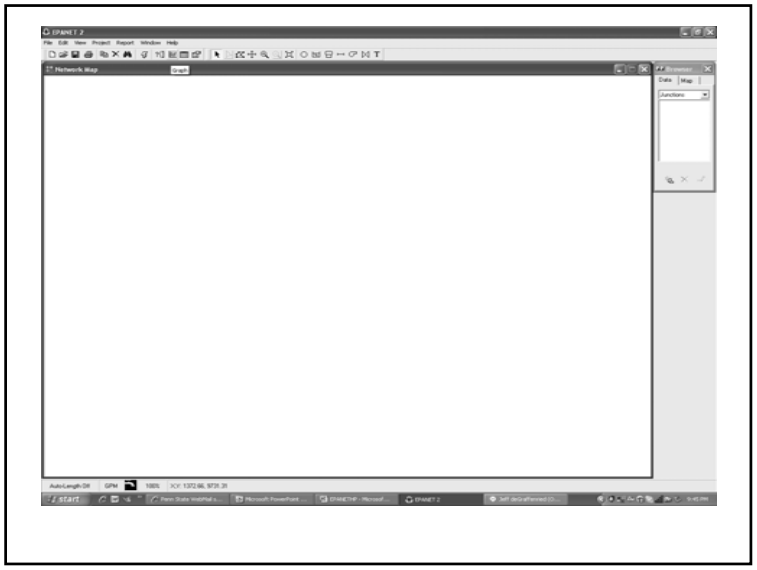


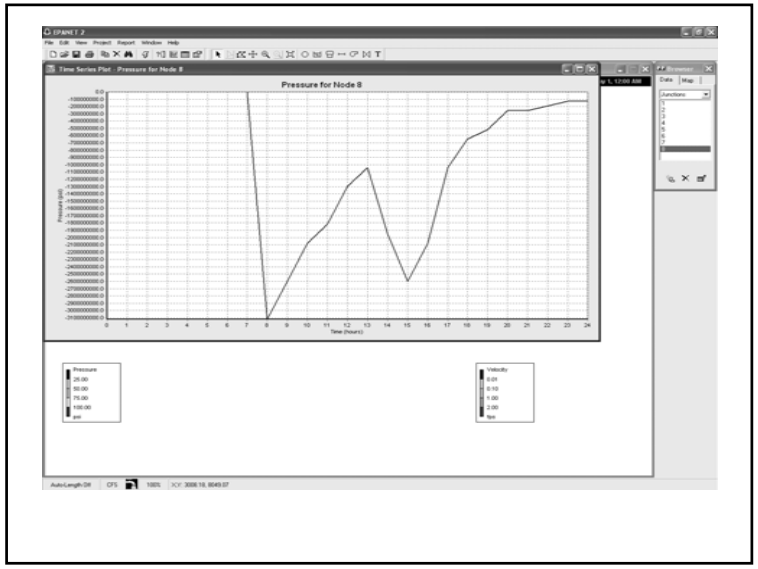


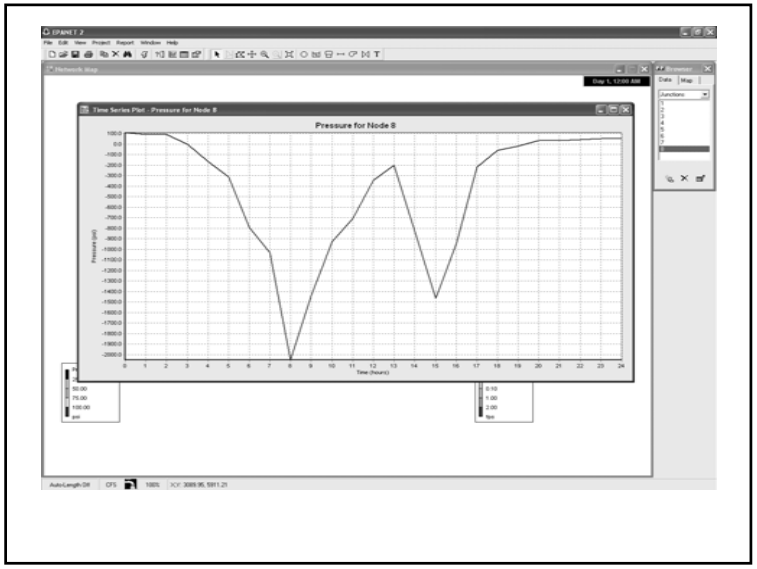









Pressure for Node 8


Pressure for Node 8

Adding A Pump

To add a pump:

1. Click the pump button on the general toolbar
2. Click on the beginning and end nodes where the pump is located.
3. Select Curves from the data tab in the browser
4. Click the Add button to add a new curve
5. In the curve editor window, select curve type Pump.
6. Enter a pump design flow and head. This will calculate automatically the equation of the pump.
7. Save the curve. Click OK.
8. Double-click on the pump to display its properties.
9. Write CU1 in pump curve. Run the program.

Adding a Reservoir

To add a reservoir:

1. Click the reservoir button on the general toolbar
2. The reservoir is located in the same location where the tank was.
3. Click in the pump button in the general toolbar
4. Connect the reservoir and the node 1 with the pump.
5. Select Curves from the data tab in the browser
6. Click the Add button to add a new curve
7. In the curve editor window, select curve type Pump.
8. Enter a pump design flow and head. This will automatically calculate the equation of the pump, or design your own pump characteristics.
9. Save the curve. Click OK.
10. Double-click on the pump to display its properties.
11. Write CU1 in pump curve. Run the program.