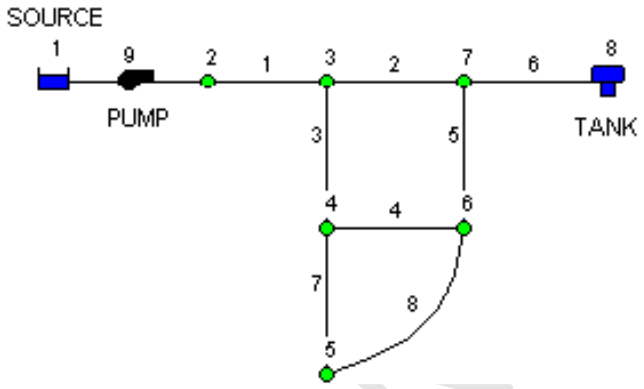
AN EXAMPLE OF WATER DISTRIBUTION NETWORK ANALYSIS USING EPANET

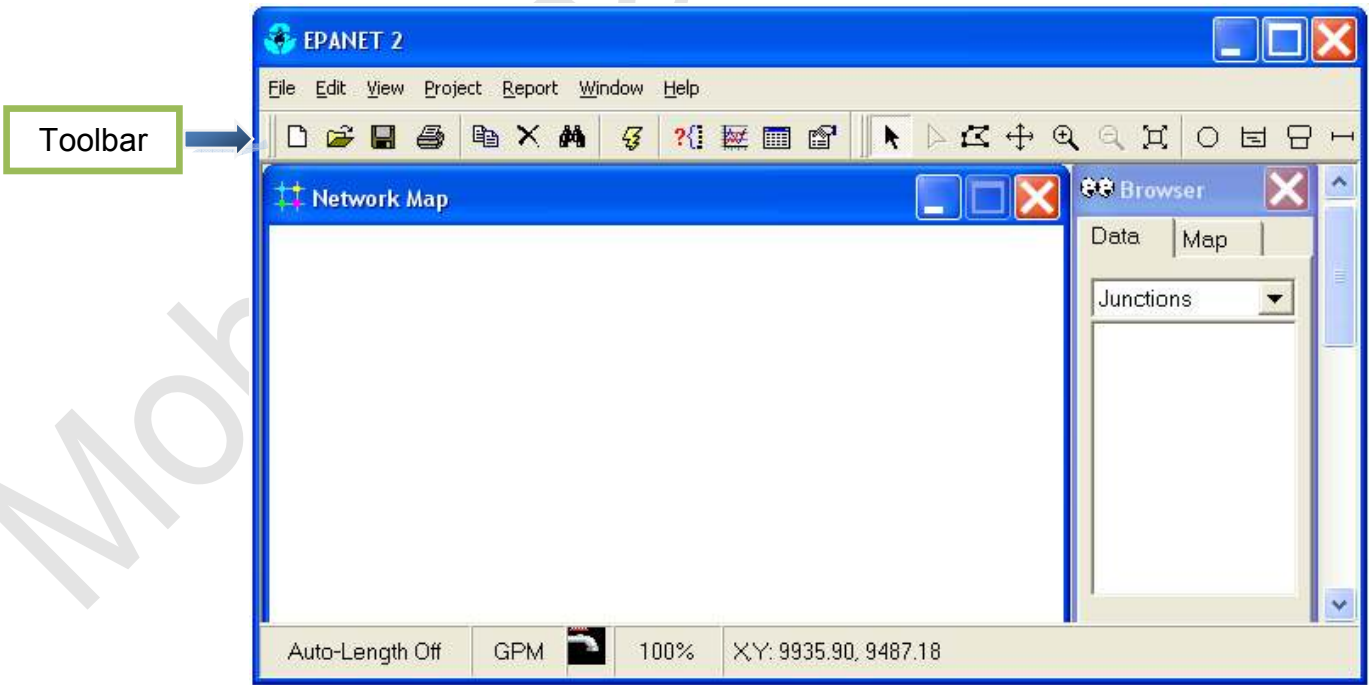
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Version 1 – June 2008

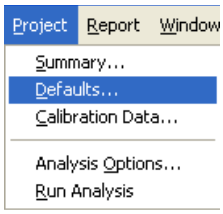
In this tutorial, we will analyze the simple distribution network shown below. It consists of a source reservoir from which water is pumped into a two-loop pipe network. There is also a pipe leading to a storage tank.



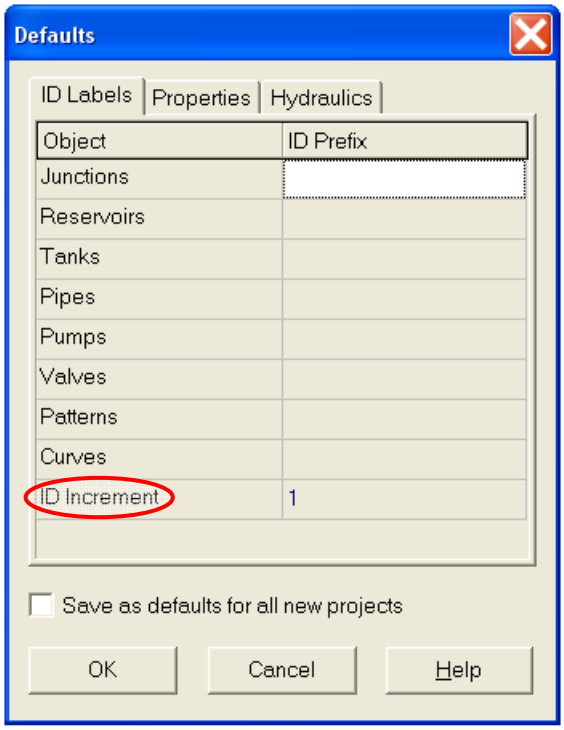
1. Launch EPANET. To do so, go to the Windows Start menu and from "**All Programs**" choose EPANET and click on EPANET 2.0.
2. The following should now appear:



3. Do the following:
   a. To create a new project select **File | New**.
   b. To work on the default settings, select **Project | Defaults** to open the Project Defaults dialog form.

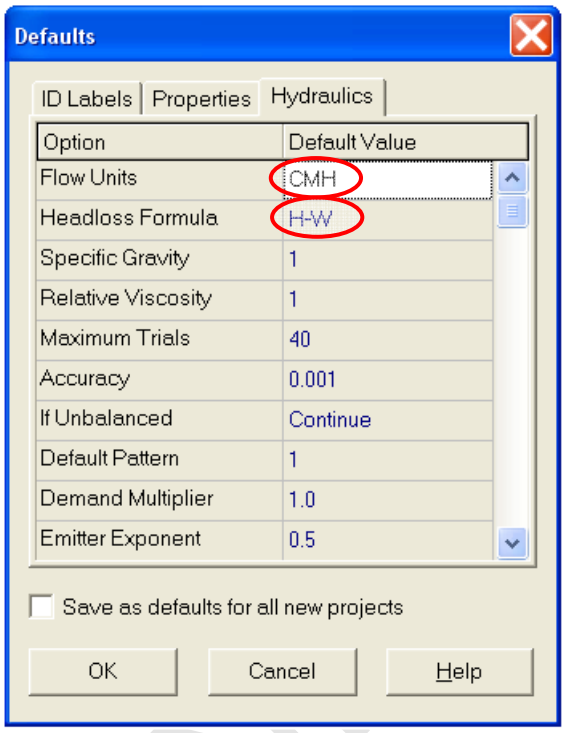


   i. On the **ID Labels** page, clear all of the ID Prefix fields and set the ID Increment to 1. This will make EPANET automatically label new objects with consecutive numbers.

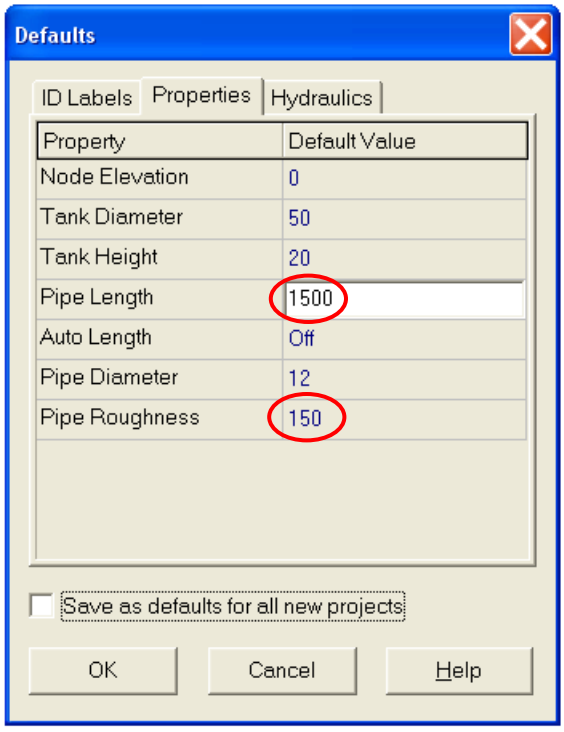


   ii. On the **Hydraulics** page of the dialog choose CMH (cubic meters per hour) as *Flow Units* and Hazen-Williams (H-W) as *Headloss Formula*.

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iii. On the properties page, choose 1500 for Pipe Length and 150 for the Pipe Roughness (Hazen-Williams coefficient)

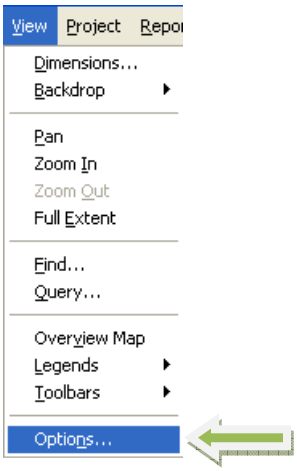


iv. Click OK to accept these choices and close the dialog.

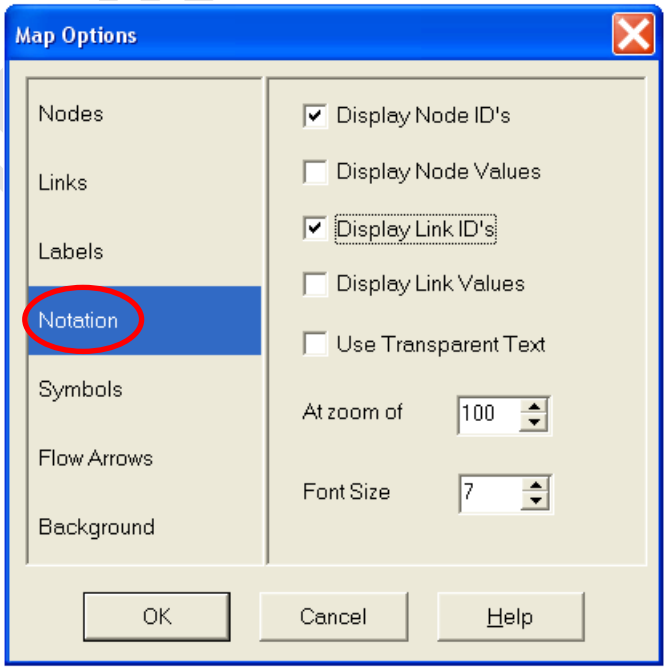
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It is very important to keep in mind that the *SI Metric units* apply when **flow units are expressed in liters or cubic meters** such as LPS (liters/sec) MLD (megaliters/day) CMH (cubic meters/hr) and CMD (cubic meters/day). In this case, we have: **Pipe diameter**: millimeters, **Tank diameter**: meters, and **Pipe length**: meters.

4. Next, we will set some map display options so that our ID labels will be displayed as we add objects to the network.
   a. Select **View | Options** to bring up the *Map Options* dialog form.

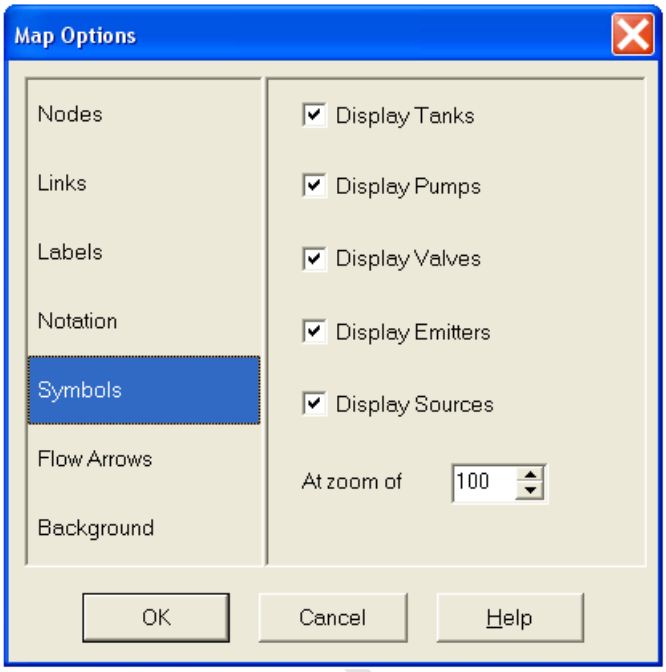


   b. Select the *Notation page* on this form and check the boxes for "Display Node IDs" and "Display Link IDs". Leave the others unchecked.



   c. Then switch to the *Symbols* page and check all of the boxes.

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d. Click the OK button to accept these choices and close the dialog.

We are now ready to begin constructing our network.

5. First add the **reservoir** by clicking the  button on the **Map Toolbar**. Then click the mouse on the map at the location where the reservoir belongs.

6. Next we will add the junction nodes. Click the  button on the **Map Toolbar** and then click on the map at the locations of nodes 2 through 7.

7. Finally add the **tank** by clicking the  button and then clicking the map where the tank is located. *Note how sequential ID labels are generated automatically as we add objects to the network*.

8. Next we will add the pipes. Let us begin with Pipe 1 connecting Node 2 to Node 3.
   a. Click the  button on the **Map Toolbar**.
   b. Click the mouse on Node 2 on the map and then on Node 3. Note how an outline of the pipe is drawn as you move the mouse from Node 2 to 3.
   c. **Repeat this procedure for pipes 2 through 7**.
   d. Pipe 8 is **curved**. To draw it, click the mouse first on Node 5. Then as you move the mouse towards Node 6, click at those points where a change of

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direction is needed to maintain the desired shape. Complete the process by clicking on Node 6.

e. Finally, add the **pump** by clicking the  button, clicking on Node 1 and then on Node 2.

9. The final task in building our network is to add some descriptive labels.

a. Select the  button on the **Map Toolbar** and click somewhere close to the reservoir (Node 1). An **edit box** will appear. Type in the word SOURCE and press the Enter key.
b. Click next to the pump and enter its label PUMP, then do the same for the tank.
c. Click the  button on the **Map Toolbar** to put the map into Object Selection mode rather than Text Insertion mode.

10. At this point, we have completed drawing the example network. To reshape the curved pipe 8:

a. First, click on Pipe 8 to select it and then click the  button on the **Map Toolbar** to put the map into Vertex Selection mode.
b. Select a vertex point on the pipe by clicking on it and then drag it to a new position with the left mouse button held down.
c. If required, vertices can be added or deleted from the pipe by right clicking the mouse and selecting the appropriate option from the popup menu that appears.
d. When finished, click the  button to return to Object Selection mode.

11. As objects are added to our project, EPANET assigns them a default set of properties. To change the value of a specific property for an object we must select the object into the **Property Editor** (shown below). There are several different ways to do this. If the Editor is already visible then you can simply click on the object or select it from the Data page of the Browser. If the Editor is not visible then you can make it appears by one of the following actions:

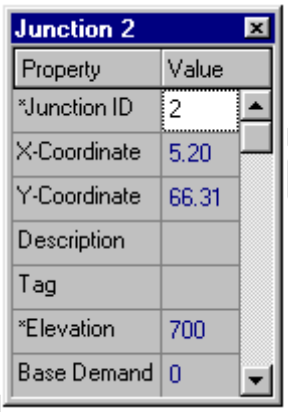
a. Double-click the object on the map
b. Right-click on the object and select Properties from the pop-up menu that appears
c. Select the object from the Data page of the Browser window and then click the Browser's Edit button . Whenever the Property Editor has the focus you can press the F1 key to obtain fuller descriptions of the properties listed

12. The nodes in our example network are assumed to have the following properties:

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Node	Elevation (m)	Demand (CMH)
1	700	0
2	700	0
3	710	150
4	700	150
5	650	200
6	700	150
7	700	0
8	830	0

a. Let us begin by selecting Junction 2 into the **Property Editor**. So double click on it.



b. Enter the elevation and demand for this node in the appropriate fields. For the demand use the field named "*Base Demand*"[1]. You can use the Up and Down arrows on the keyboard or the mouse to move between fields. After this, we need only to click on another node to have its properties appear next in the Property Editor.
c. For the Reservoir (Node 1), enter its elevation of 700 in the *Total Head* field. For the tank (Node 8), enter 830 for its elevation, 4 for its Initial Level, 20 for its Maximum Level, and 60 for its Diameter.

13. Assume that the pipes in our network have the following lengths and diameters:

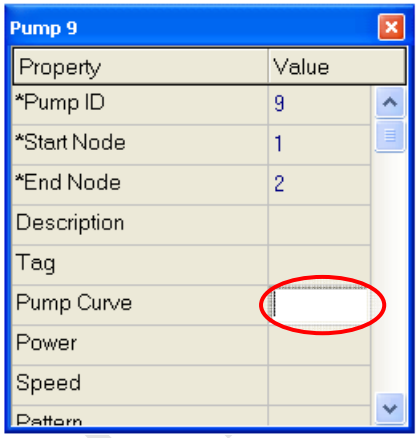
Pipe	Length (km)	Diameter (inches)
1	3	14
2	5	12
3	5	8
4	5	8
5	5	8
6	7	10
7	5	6
8	7	6

[1] baseline or average demand for the category (required)

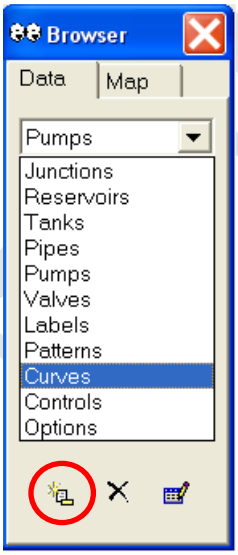
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a. All Roughness Coefficients (CHW-Factors) are 150.
b. Following the same procedure used for nodes, we simply click on each pipe to move from pipe to pipe to enter its properties into the **Property Editor**.

14. For the pump, we need to assign it a pump curve (head versus flow relationship):
a. Select the pump (Link 9) into the **Property Editor** and enter the ID label 1 in the Pump Curve field.

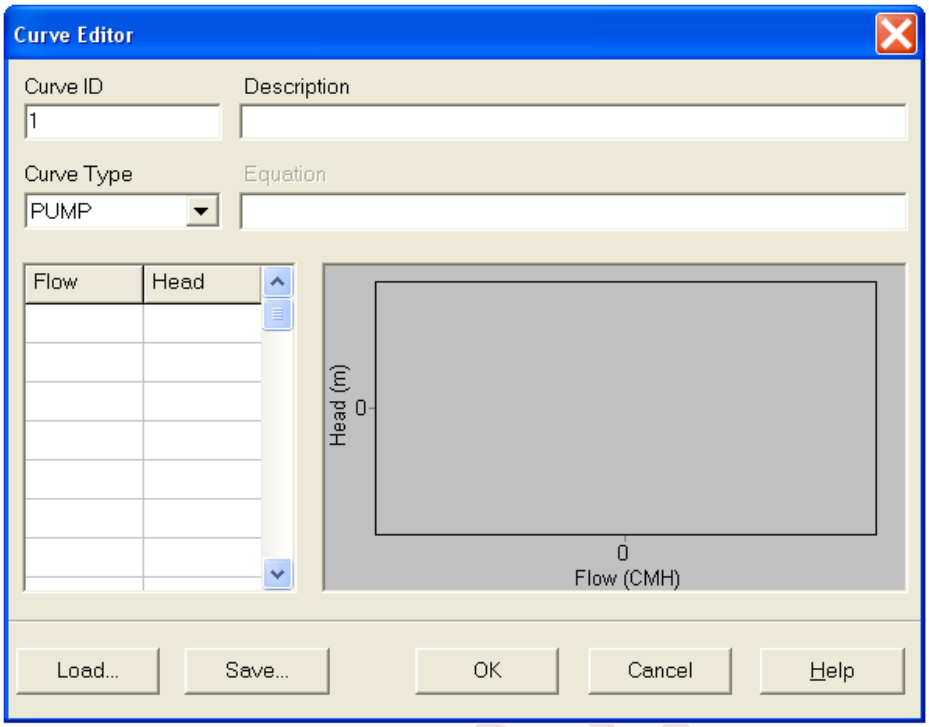


b. Create Pump Curve 1. From the Data page of the Browser window, select Curves from the dropdown list box.



c. Then click the Add button . A new Curve 1 will be added to the database and the **Curve Editor** dialog will appear.

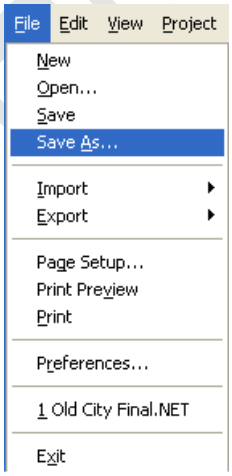
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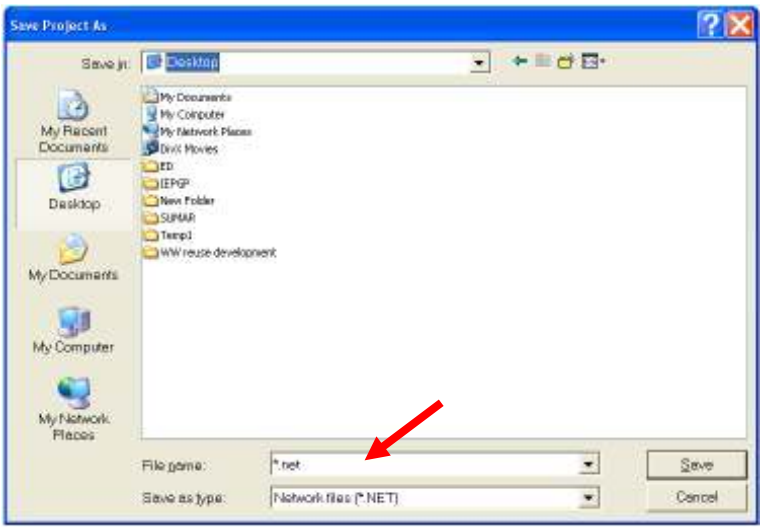


d. Enter the pump's design flow (600) and head (150) into this form. EPANET will automatically create a complete pump curve from this single point. The curve's equation is shown along with its shape.
e. Click the OK button on the dialog to accept the pump curve.

15. Having completed the initial design of our network it is a good idea to save our work to a file at this point.

a. From the **File** menu select the **Save As** option. In the **Save As** dialog that appears, select a folder and file name under which to save this project.





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b. Click **Save** to save the project.

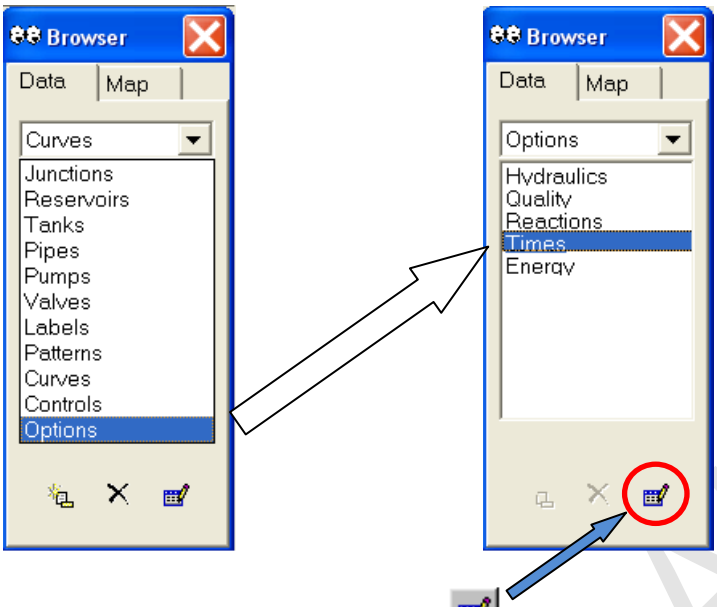
The project data is saved to the file in a special binary format. If you wanted to save the network data to file as readable text, use the **File | Export | Network** command instead

16. We now have enough information to run a *single period* (or snapshot) hydraulic analysis on our example network. To run the analysis select **Project | Run Analysis** (or click the  button). If it ran successfully you can view the computed results in a variety of ways. Try some of the following:
    a. Select Node Pressure from the Browser's Map page and observe how pressure values at the nodes become color-coded. To view the Legend for the color-coding, select **View | Legends | Node** (or right-click on an empty portion of the Map and select Node Legend from the popup menu). To change the legend intervals and colors, right-click on the legend to make the **Legend Editor** appear.
    b. Bring up the **Property Editor** (double-click on any node or link) and note how the computed results are displayed at the end of the property list.
    c. Create a tabular listing of results by selecting **Report | Table** (or by clicking the  button).

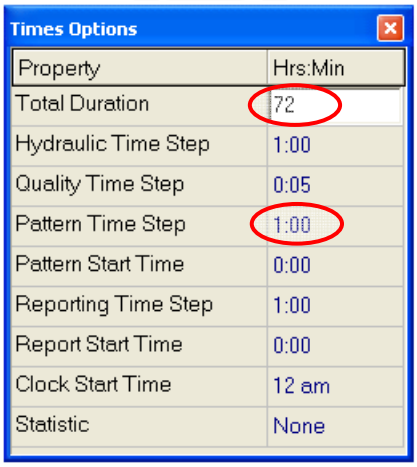
If the run was unsuccessful then a Status Report window will appear indicating what the problem was

17. To make our network more realistic for analyzing an *extended period* of operation we will create a **Time Pattern** that *makes demands at the nodes vary in a periodic way over the course of a day*. For this simple example, we will use a *pattern time step* of 1 hour. This will cause demands to change at 24 different times of the day. To set the pattern time step as well as the simulation duration:
    a. Select **Options** from the Data Browser and select **Times**.

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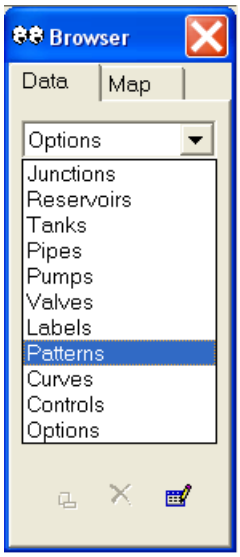


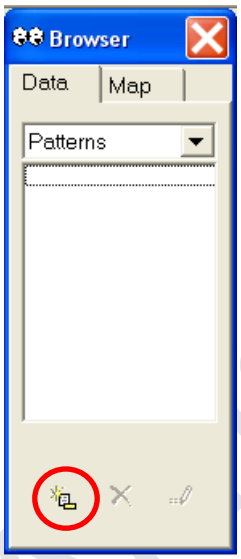
b. Click the Browser's Edit button  to make the **Property Editor** appear.
c. Enter 1 for the value of the Pattern Time Step.
d. Enter 72 hours (3 days) for the simulation Duration.



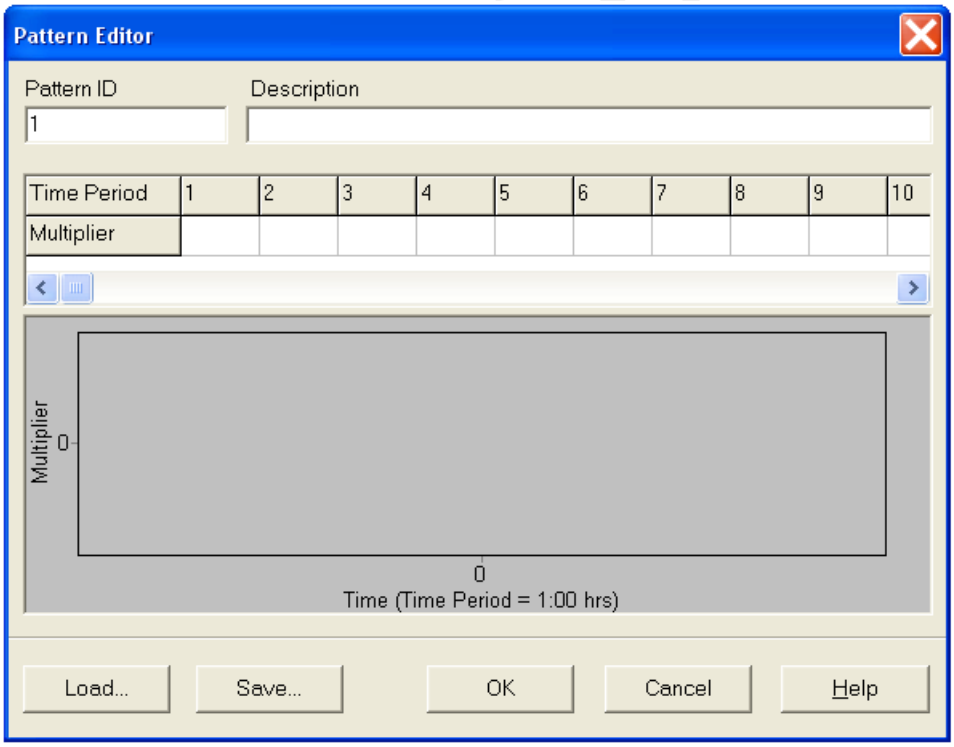
18. To create the time pattern:
    a. Select the **Patterns** category in the Data Browser

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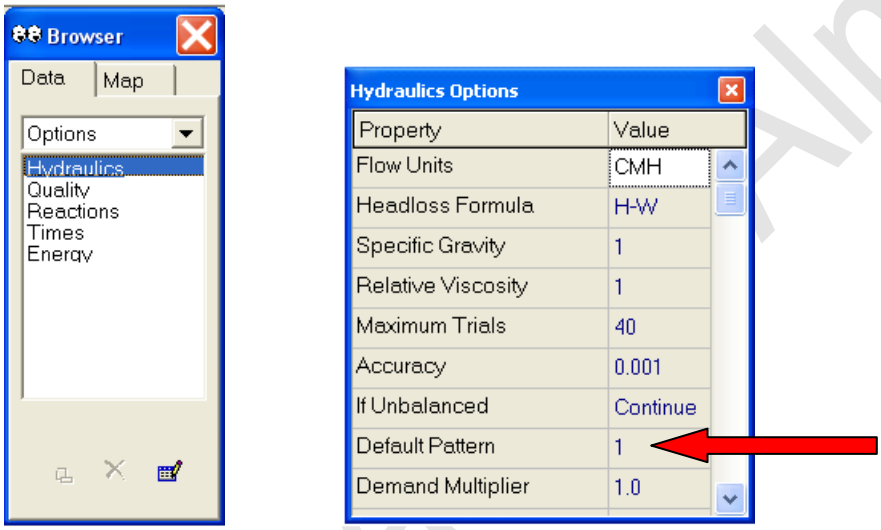


b. Click the  button. A new Pattern 1 will be created and the Pattern Editor dialog should appear.



c. Enter the multiplier values 0.45, 0.5, 0.5, 0.65, 0.65, 0.55, 0.75, 1.0, 1.5, 1.4, 1.25, 1.18, 1.25, 1.25, 1.25, 1.3, 1.3, 1.5, 1.7, 1.6, 1.32, 1.0, 0.75, 0.65, and 0.52 for the time periods 1 to 24.
d. Click the **OK** button to close the **Pattern Editor**.

19. The multipliers are used to modify the demand from its base level in each time period. Since we are making a run of 72 hours, the pattern will wrap around to the start once again after each 24-hour interval of time.
20. We now need to assign Pattern 1 to the Demand Pattern property of all of the junctions in our network. We can utilize one of EPANET's Hydraulic Options to avoid having to edit each junction individually. If you bring up **Options** in the **Property Editor** and then select **Hydraulics** you will see that there is an item called **Default Pattern**. *Setting its value equal to 1* will make the Demand Pattern at each junction equal Pattern 1 providing no other pattern is assigned to the junction.



21. We are now ready to run the *extended period* hydraulic analysis. Once again select **Project | Run Analysis** (or click the button). For extended period analysis you have several more ways in which to view results:
    a. Use the scrollbar in the Map Browser's Time controls to display the network map at different points in time.
    b. Use the VCR-style buttons in the Map Browser to animate the map through time. Click the button to start the animation and the button to stop it.
    c. Create a time series plot for any node or link. For example, to see how the water elevation in the tank changes with time:
        i. Click on the tank.
        ii. Select **Report | Graph** (or click the button) to display a Graph Selection dialog.
        iii. Select the Time Series button on the dialog.
        iv. Select Head as the variable to plot.
        v. Click OK to accept your choice of graph.

22. Note the periodic behavior of the water elevation in the tank over time.

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