

3.4 Automated Fire Flow Analysis

One of the primary goals of a water distribution system is to provide adequate capacity to fight fires. Bentley WaterCAD V8i automated fire flow analysis can be used to determine if the system can meet the fire flow demands while maintaining minimum pressure constraints. Fire flows can be computed for all nodes in the system, or you can create a selection set consisting of specific nodes where you wish to test available flow.

Fire flows are computed at each node by iteratively assigning demands and computing system pressures. The model assigns the fire flow demand to a node and checks the model, checking to see if all pressure and velocity constraints are met at that demand. If a constraint is not met, the flow is reduced until the constraint is just met; if all constraints are exceeded, the fire flow is increased until the constraint is barely met within a tolerance. The analysis automatically rechecks the system pressures if a constraint is violated. Iterations continue until the constraints are met, or until the maximum number of iterations is reached.

The purpose of this example is to walk you through the steps to create, calculate, and analyze a fire-flow scenario. This lesson again uses the distribution system from the previous lessons.

Step 1: Inputting Fire Flow Data

1. Start Bentley WaterCAD V8i and open the **LESSON5.wtg** file, found in the Bentley\WaterGEMS\Lesson folder.
Or
if you have previously completed the [Reporting Results](#) lesson, you can use your **MYLESSON4** file.
2. Choose File > Save As and save as MYLESSON5.

3. Choose File > Project Properties and name the title of the project **Lesson 5—Fire Flow Analysis**.

Project Properties

Title: Lesson 5-Fire Flow Analysis

File Name: C:\Program Files\Bentley\WaterGEMS\Lessons\Lesson5.wtg

Engineer:

Company:

Date: 12/13/2005

Notes:

OK Cancel Help

4. Click OK.
5. Previously, you ran an analysis with a fire flow at node J-6 by manually adding a large demand to the individual node. Before running the automated fire flow analysis, you will create a new Demand Alternative, removing that demand. In the U.S., fire flows are generally added to max day demands.
 - a. Click Analysis > Alternatives.
 - b. Expand the Demand Alternative and select Average Daily with 2000 l/min Fire Flow. Right-click and select New > Child Alternative.

- c. Double-click to open the new alternative and put a check in the box for J-6.

	*	ID	Label	Demand Coll
53: J-1	☐	53	J-1	<Collection: 2 ite
54: J-2	☐	54	J-2	<Collection: 2 ite
55: J-3	☐	55	J-3	<Collection: 2 ite
56: J-4	☐	56	J-4	<Collection: 2 ite
57: J-5	☐	57	J-5	<Collection: 1 ite
58: J-6	☒	58	J-6	<Collection: 3 ite

	Demand (Base) (L/min)	Pattern (Demand)
1	280.00	42: Residential
2	76.00	43: Commercial
3	2,000.00	44: 3-Hour Fire
*		

* ☒ = Base data ☒ = Local data ☐ = Inherited data

Report Close Help

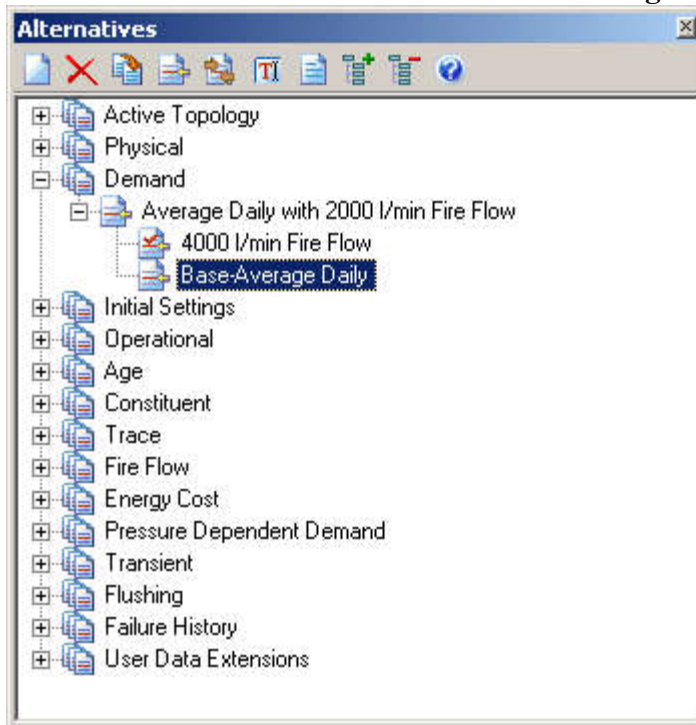
- d. In the Demands tab, select the row with 2,000 Flow and 3-Hour Fire and click

	Demand (Base) (L/min)	Pattern (Demand)
1	280.00	42: Residential
2	76.00	43: Commercial
*		

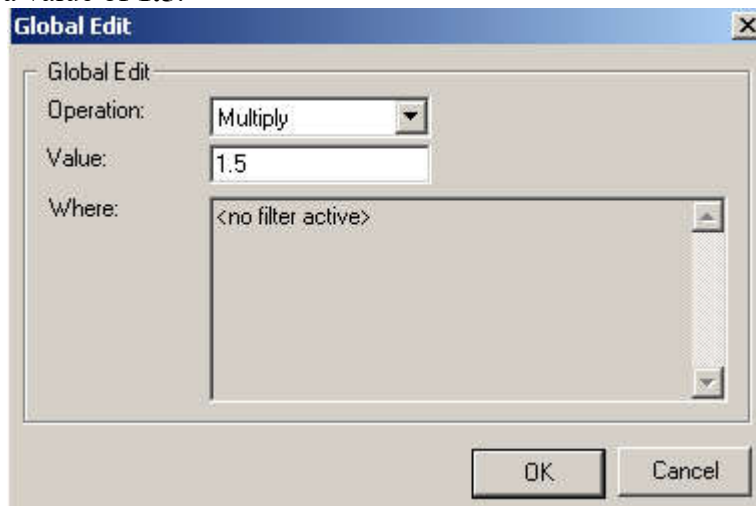
to delete it.

- e. Click Close to exit the Demand Alternative.

6. Click to Rename  this Alternative **Base-Average Daily**.



7. You are going to analyze the fire flows by adding to the Maximum Day Demands, which are 1.5 times the Average Day Demands.
- Right-click on Base-Average Daily then select New > Child Alternative.
 - Double click to open the Alternative and highlight the J-1 row. Right-click the Demands column and select **Global Edit**. Set the Operation to multiply, and enter a value of **1.5**.



- Click **OK**.
 - Repeat step b and c for J-2 through J-6. Click **Close** to exit the Demand Alternative.
 - Click to Rename  this Alternative **Max. Day**.
8. Select the **Fire Flow** alternative and expand to select the Base-Fire Flow Alternative.

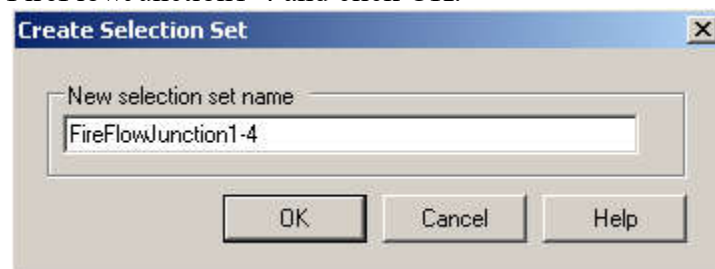
9. Click Open  to set up the Base-Fire Flow Alternative.
- In the **Fire Flow (Needed)** field, enter **3000 l/min.**
 - In the **Fire Flow (Upper Limit)** field enter **6000 l/min.**
 - Apply Fire Flows By** should be set to **Adding to Baseline Demand.**

This selection means that when Bentley WaterCAD V8i performs the analysis, the fire flow will be added to any demands already assigned to the junction. Alternatively, you could have selected to replace these demands, so that the fire flow would represent the total demand at the node.

- Pressure Constraints Pressure (Residual Lower Limit) and Pressure (Zone Lower Limit) should be set to **150 kPa.**
- Leave the check box for **Use Minimum System Pressure Constraint** cleared, so that the minimum pressure will only be checked for the zone a particular node is in.

If you had multiple zones within your project and wanted to insure that a minimum system-wide pressure constraint was met, you could check the **Use Minimum System Pressure Constraint** box and enter it in the box provided. This box is grayed out until the check box is activated.

- Create a selection set to choose from the Fire Flow Nodes drop-down menu. For this example, a fire flow analysis is only needed for the junctions at the four street corners in our drawing.
- The Fire Flow Alternative manager can remain open. In the drawing and while pressing the <Shift> key, click nodes **J-1, J-2, J-3, and J-4.**
- Right-click and select **Create Selection Set**, then name the set FireFlowJunction1-4 and click OK.



- i. In the Fire Flow Alternative manager, select FireFlowJunction1-4 from the Fire Flow Nodes drop-down menu.

Fire Flow : Base-Fire Flow

☐ Use Velocity Constraint?

Velocity (Upper Limit): (N/A) m/s

Pipe Set: All Pipes

Fire Flow Constraints

Fire Flow (Needed): 3,000.00 L/min

Fire Flow (Upper Limit): 0.00 L/min

Apply Fire Flows By: Adding to Baseline Demand

Pressure Constraints

Pressure (Residual Lower Limit): 150.00 kPa

Pressure (Zone Lower Limit): 150.00 kPa

☐ Use Minimum System Pressure Constraint?

Pressure (System Lower Limit): (N/A) kPa

Auxiliary Output Settings

Fire Flow Auxiliary Results Type: None

☐ Use Node Pressure Less Than?

Node Pressure Less Than: 0.00 kPa

☐ Use Pipe Velocity Greater Than?

Pipe Velocity Greater Than: 0.00 m/s

Auxiliary Output Selection Set: <No Elements>

Fire Flow Nodes: 103: FireFlowJunction1-4

	*	ID	Label	Specify Local Fire Flow Constraints?	Velocity (Upper Limit) (m/s)	Fire Flow (Needed) (L/min)	Fire Flow (Upper Limit) (L/min)	Pressure (Residual Lower Limit) (kPa)	Pressure (Zone Lower Limit) (kPa)	Pressure (System Lower Limit) (kPa)
53: J-1	☒	53	J-1	☐	(N/A)	3,000.00	0.00	150.00	150.00	
54: J-2	☒	54	J-2	☐	(N/A)	3,000.00	0.00	150.00	150.00	
55: J-3	☒	55	J-3	☐	(N/A)	3,000.00	0.00	150.00	150.00	
56: J-4	☒	56	J-4	☐	(N/A)	3,000.00	0.00	150.00	150.00	

* ☒ = Base data ☒ = Local data ☐ = Inherited data

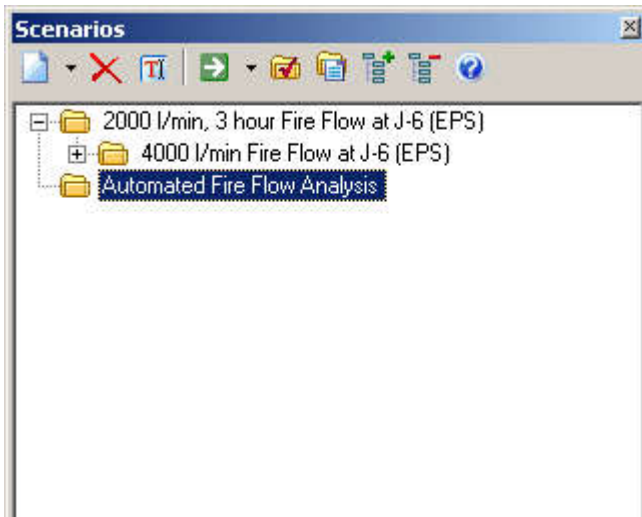
Report Close Help

10. Close the Fire Flow Alternative manager.

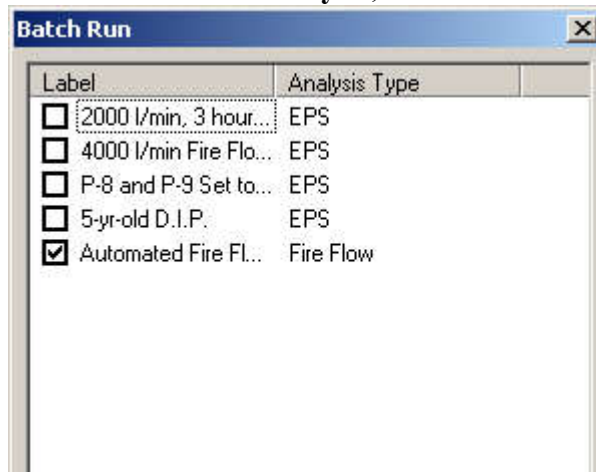
Step 2: Calculating a Fire Flow Analysis

1. Click **Analysis > Scenarios** or click .
2. In the Scenarios dialog, click New > Base Scenario.

3. Name the new Scenario **Automated Fire Flow Analysis**.



4. Double-click the **Automated Fire Flow Analysis** scenario to open the properties editor.
 - a. Change the Physical Alternative to **P-8 and P-9 Set to 200 mm**.
 - b. Change the Demand to **Max. Day** and leave all other Alternatives set to their defaults.
 - c. Close the properties dialog.
5. In the Scenarios manager, make Automated Fire Flow Analysis the current scenario by highlighting it and clicking the Make Current button .
6. Click the **Analysis > Calculation Options**, double-click on **Base under Steady State/EPS** and set the **Calculation Type** to **Fire Flow**.
7. Close the Properties editor.
8. Run the Scenario.
 - a. From the Scenarios Manager click Batch Run.
 - b. Check **Automated Fire Flow Analysis**, and clear the other Scenarios, if



necessary.

- c. Click **Batch** to run the analysis, and **Yes** at the confirmation prompt.
- d. When the calculation is complete, click **OK** and close the Scenarios Manager.

Step 3: Viewing Fire Flow Results

1. Make sure that **Automated Fire Flow Analysis** is selected in the Scenario list box.
2. Click **View > FlexTables**. Under **Tables - Predefined**, double-click the **Fire Flow Node**

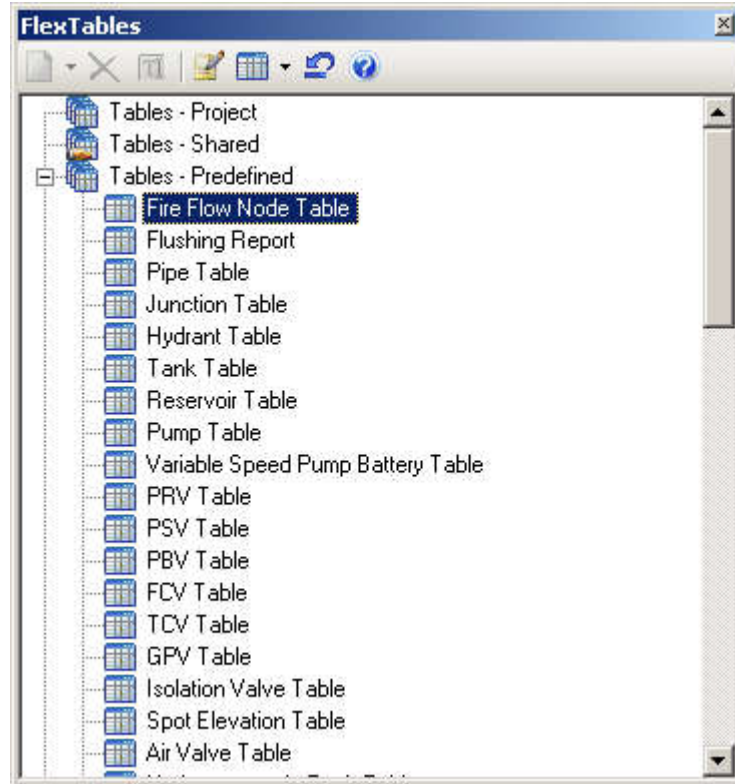


Table.

In the Satisfies Fire Flow Constraints column, all of the boxes are checked except for the nodes that you did not analyze, because the specified needed flow of 3000 l/min. was available and minimum pressures were exceeded.

For nodes J-1 and J-3, pressures were computed for the Fire Flow Upper Limit of 6000 l/min. because none of the node pressures ever dropped below specified minimum pressures and no velocity constraint was specified.

Nodes J-2 and J-4 reached their minimum residual pressures at flows slightly below the maximum of 6000 l/min.

The report contains the Minimum System Pressure (excluding the current node being flowed) and its location.

3. When you are finished reviewing the report, click **Close** in the Bentley WaterCAD V8i Fire Flow Report dialog box and save your file as **MYLESSON5**.