LECTURE 8-A
INTRODUCTION TO EPANET

CEEN 4800/6965 - Special Topics
Geographic Information Systems and Hydrologic & Hydraulic Modeling
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Department of Civil / Environmental & Chemical Engineering

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OUTLINE

- Download instructions
- EPANET description
- EPANET capabilities
- EPANET applications
- User interface
- EPANET input data
- EPANET output results
- Tutorial
- Exercise
- Homework

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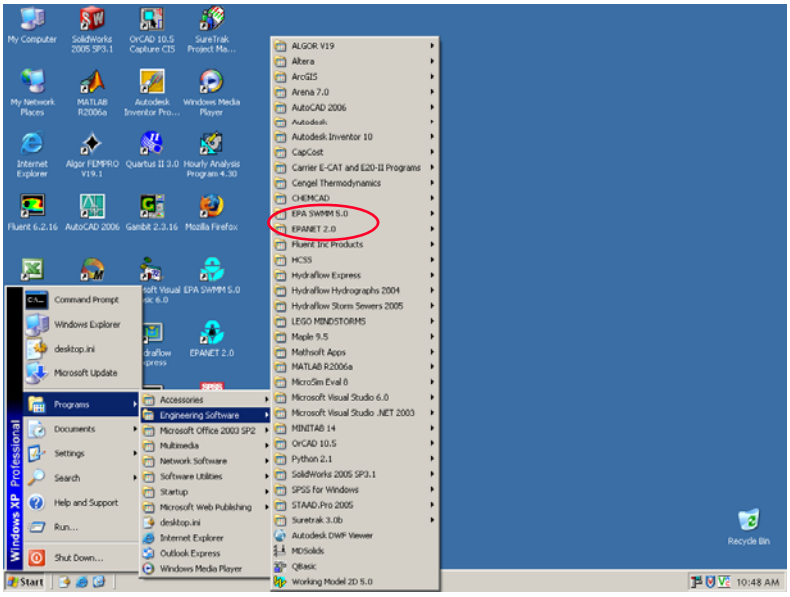
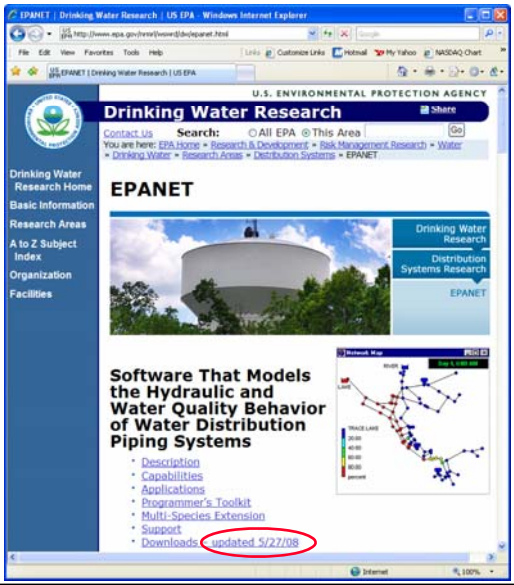
EPANET IN COMPUTER LAB



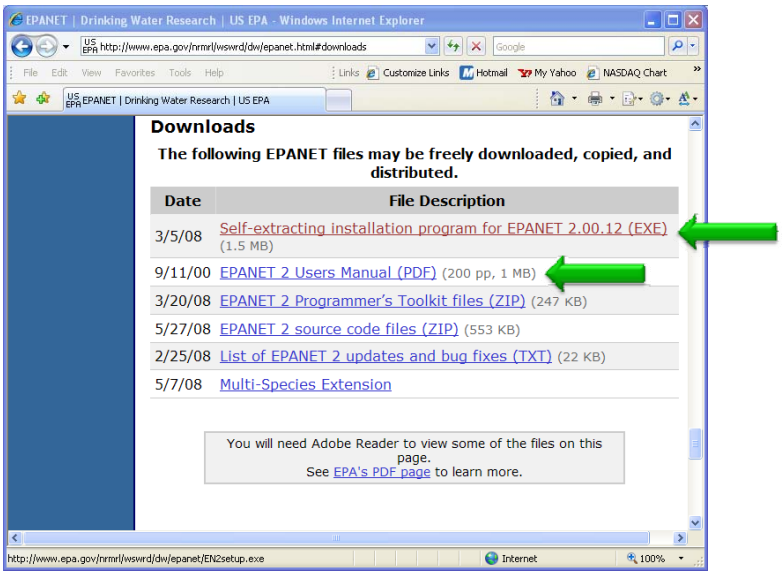
EPANET DOWNLOAD

http://www.epa.gov/ORD/NRMRL/wswrd/epanet.html



EPANET DOWNLOAD

http://www.epa.gov/ORD/NRMRL/wswrd/epanet.html#Downloads



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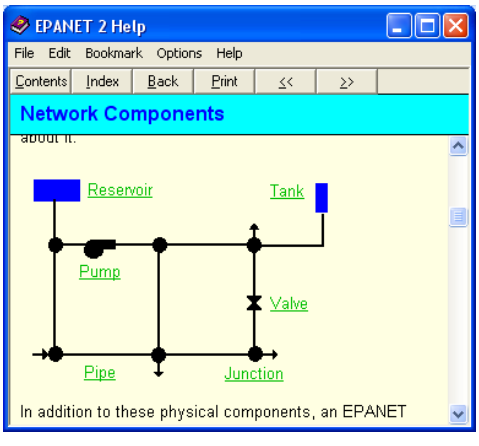
DESCRIPTION

- EPANET models flow rate, pressure, and water quality (contaminant concentration) in a water distribution system.
- The modeled network can consist of:
  - Nodes:
    - pipe junctions
    - storage tanks, and
    - reservoirs.
  - Links:
    - pipes
    - pumps
    - valves
  - EPANET demo



Shortcut to Net1.net.lnk

C:\Documents and Settings\sshamsi\My Documents\2008\YSUGIS08\Lectures\10-EPANET\EPANET\AGNETDemo1\Net1.net

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DESCRIPTION

- EPANET models:
  - flow of water in pipes,
  - pressure at junctions,
  - height of water in tanks,
  - concentration of a chemical,
  - water age, and
  - source tracing (trace the source of a contaminant)

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CAPABILITIES

- Extended period hydraulic analysis
- Can model systems of any size
- Computes friction head loss using one of the following equations
  - Hazen-Williams,
  - Darcy-Weisbach, or
  - Chezy-Manning
- Allows minor head losses for bends, fittings, etc.
- Models constant or variable speed pumps
- Computes pumping energy and cost

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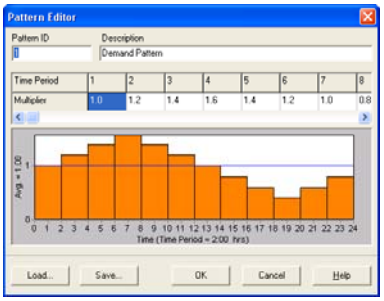
CAPABILITIES

- Models various types of valves including:
  - Shutoff valves
  - Check valves
  - Pressure regulating valves
  - Flow control valves
- Models storage tanks of any shape (i.e., diameter can vary with height)
- Allows multiple demand categories at nodes, each with its own pattern of time variation



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APPLICATIONS

- Plan and improve a system's hydraulic performance
- Pipe, pump and valve placement and sizing
- Fire flow analysis
- Maintain and improve the quality of water delivered to consumers
- Study disinfectant loss and by-product formation
- Evaluate alternative strategies for improving water quality such as:
  - Altering source utilization within multi-source systems,
  - Modifying pumping and tank filling/emptying schedules to reduce water age,
  - Utilizing booster disinfection stations at key locations to maintain target residuals

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USER INTERFACE

- Provides a visual network editor that simplifies the process of building piping network models and editing their properties.
- Various data reporting and visualization tools are used to assist in interpreting the results of a network analysis. These include:
  - Graphical views (time series plots, profile plots, contour plots, etc.),
  - Tabular views, and
  - Special reports (e.g., energy usage).

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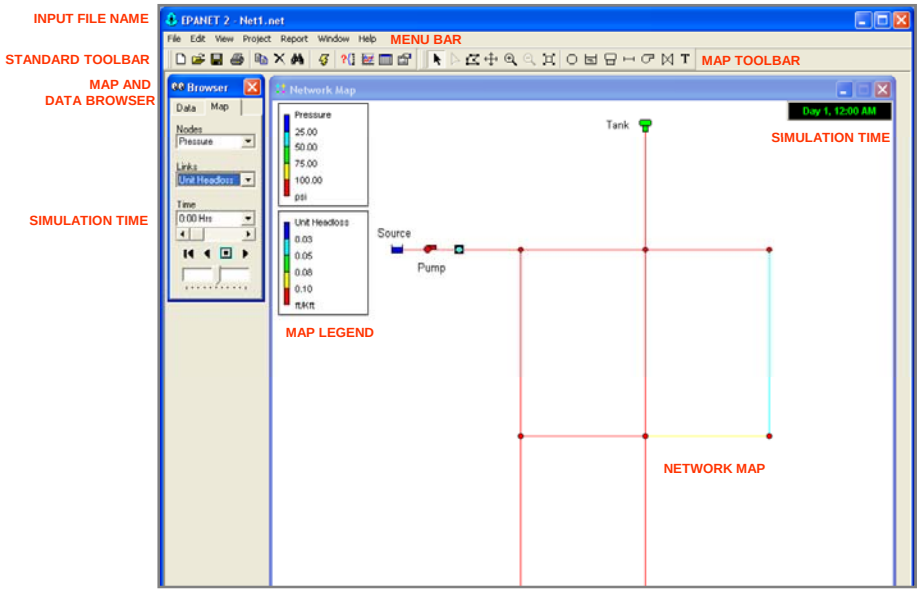
USER INTERFACE



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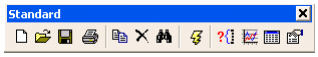
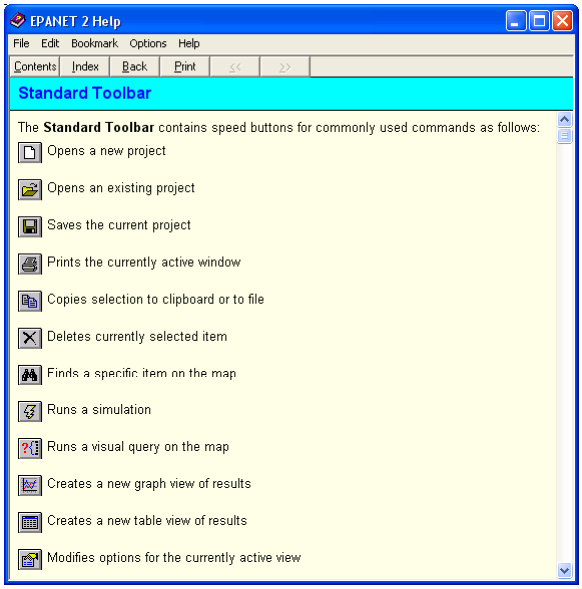
STANDARD TOOLBAR





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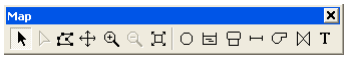
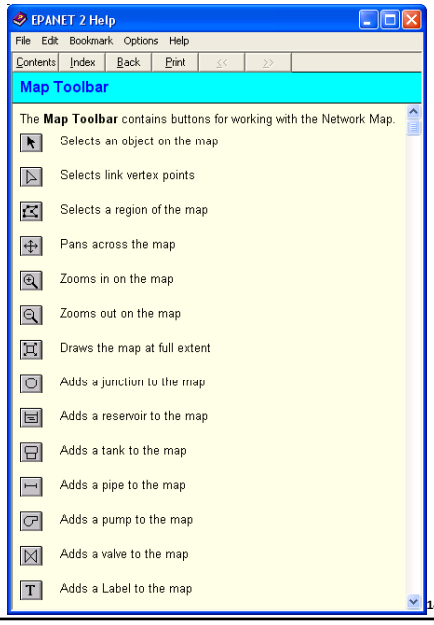
MAP TOOLBAR





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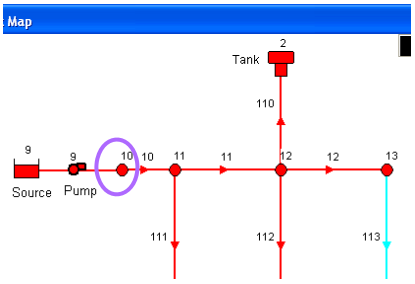
EPANET INPUT

- **Junctions**
  - Coordinates (can import from GIS)
  - Elevation
  - Demand (gallons per minute)
  - Initial quality



Junction 10

Property	Value
*Junction ID	10
X-Coordinate	20.00
Y-Coordinate	70.00
Description	
Tag	
*Elevation	710
Base Demand	0
Demand Pattern	
Demand Categories	1
Emitter Coeff.	
Initial Quality	0.5
Source Quality	
Actual Demand	0.00
Total Head	1004.35
Pressure	127.54
Quality	0.50

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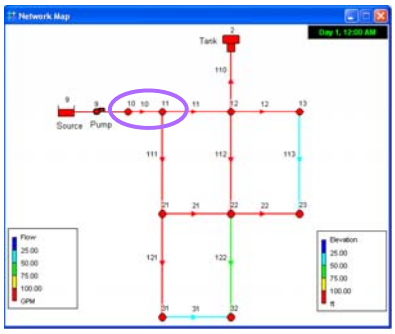
EPANET INPUT

- **Pipes**
  - Length
  - Diameter
  - Roughness coefficient (Hazen-Williams C factor)



Pipe 10

Property	Value
*Pipe ID	10
*Start Node	10
*End Node	11
Description	
Tag	
*Length	10530
*Diameter	18
*Roughness	100
Loss Coeff.	0
Initial Status	Open
Bulk Coeff.	
Wall Coeff.	
Flow	1866.18
Velocity	2.35
Unit Headloss	1.82
Friction Factor	0.032
Reaction Rate	0.00
Quality	0.50
Status	Open

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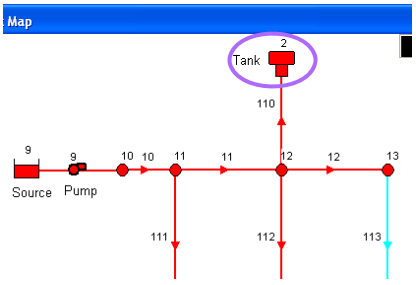
EPANET INPUT

- Tanks data
  - Coordinates (can import from GIS)
  - Elevation
  - Levels
    - Initial
    - Minimum
    - Maximum
  - Diameter
  - Volume



Tank 2

Property	Value
*Tank ID	2
X-Coordinate	50.00
Y-Coordinate	90.00
Description	
Tag	
*Elevation	850
*Initial Level	120
*Minimum Level	100
*Maximum Level	150
*Diameter	50.5
Minimum Volume	0
Volume Curve	
Mixing Model	Mixed
Mixing Fraction	
Reaction Coeff.	
Initial Quality	1.0
Source Quality	
Net Inflow	766.18
Elevation	970.00
Pressure	52.00
Quality	1.00

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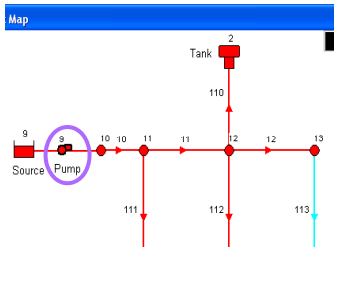
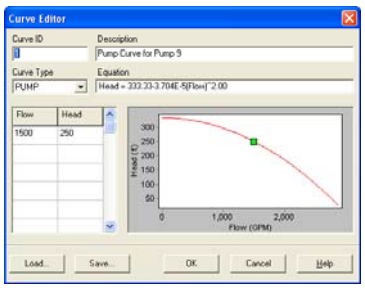
EPANET INPUT

- Pumps data
  - Start node
  - End node
  - Pump curve
  - Initial status (open, close)
- Valves data





Pump 9

Property	Value
*Pump ID	9
*Start Node	9
*End Node	10
Description	
Tag	
Pump Curve	1
Power	
Speed	
Pattern	
Initial Status	Open
Effic. Curve	
Energy Price	
Price Pattern	
Flow	1866.18
Headloss	-204.35
Quality	0.75
Status	Open

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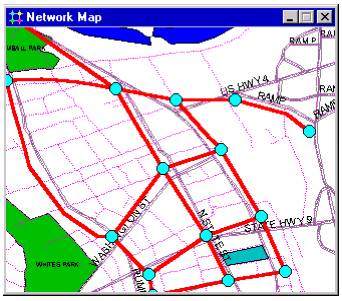
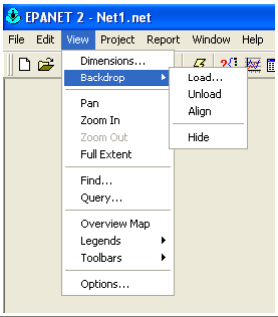
BACKDROP MAP

- EPANET can display a backdrop map behind the pipe network map.
  - street map,
  - utility map,
  - topographic map
- Simplifies the process of adding pipes to the network (heads up digitization)
- Windows enhanced metafile (wmf and emf) or bitmap (bmp)
  - Most CAD and GIS programs have the ability to save their drawings and maps as metafiles.
- Selecting View >> Backdrop from the Menu Bar will display a sub-menu with the following commands:
  - Load (loads a backdrop map file into the project)
  - Unload (unloads the backdrop map from the project)
  - Align (aligns the pipe network with the backdrop)
  - Show/Hide (toggles the display of the backdrop on and off)





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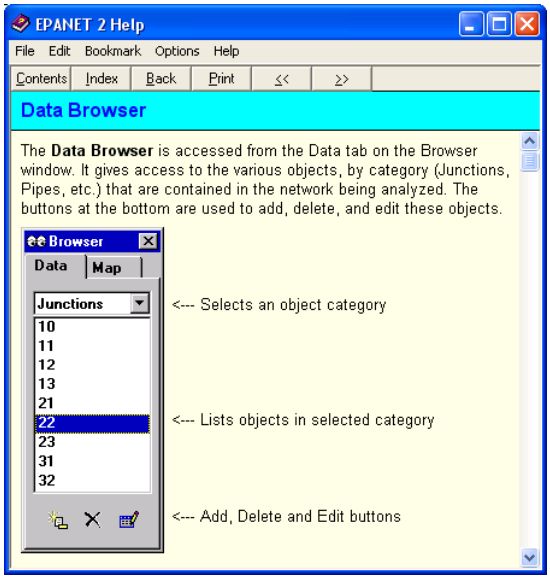
DATA BROWSER



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EPANET OUTPUT

- Junctions (nodes)
  - Pressure
  - Quality (e.g., residual chlorine concentration)
- Pipes (links)
  - Flow (gallons per minute)
  - Velocity (ft per second)
  - Head loss (ft)
- Tanks: inflow, level, quality
- Pump: flow rate

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TABULAR RESULTS

Network Table - Nodes at 0:00 Hrs

Node ID	Elevation ft	Base Demand GPM	Initial Quality mg/L	Demand GPM	Head ft	Pressure psi	Chlorine mg/L
Junc 10	710	0	0.5	0.00	1002.29	126.65	0.50
Junc 11	710	300	0.5	300.00	982.89	118.24	0.50
Junc 12	700	150	0.5	150.00	970.05	117.01	0.50
Junc 13	695	100	0.5	100.00	968.75	118.61	0.50
Junc 21	700	150	0.5	150.00	970.69	117.29	0.50
Junc 22	695	200	0.5	200.00	968.82	118.65	0.50
Junc 23	690	150	0.5	150.00	968.43	120.64	0.50
Junc 31	700	100	0.5	100.00	966.67	115.55	0.50
Junc 32	710	100	0.5	100.00	965.16	110.56	0.50
Resvr 9	800	#N/A	1.0	-1881.03	800.00	0.00	1.00
Tank 2	850	#N/A	1.0	631.03	970.00	52.00	1.00

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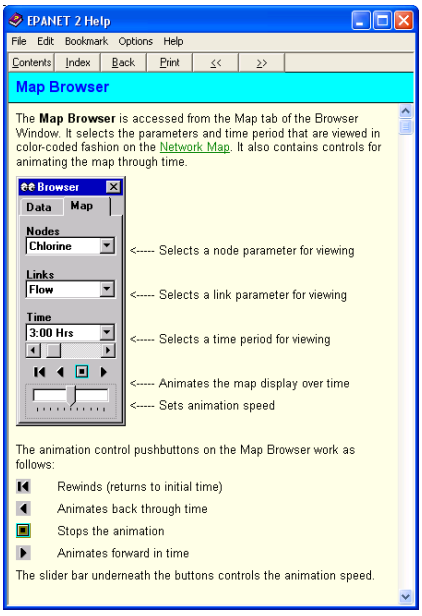
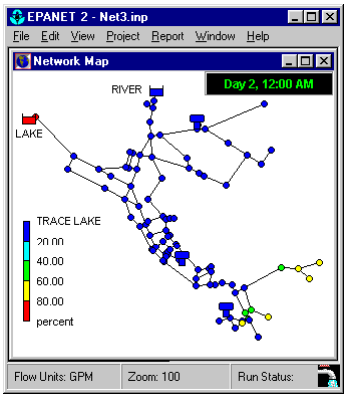
MAP BROWSER

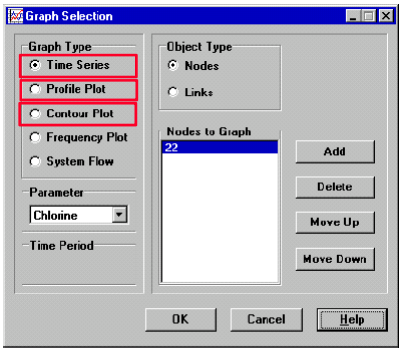


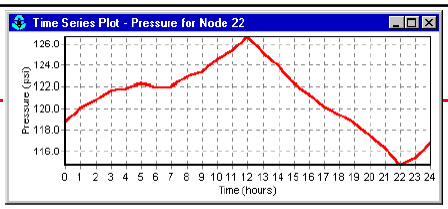
ANIMATED MAP RESULTS

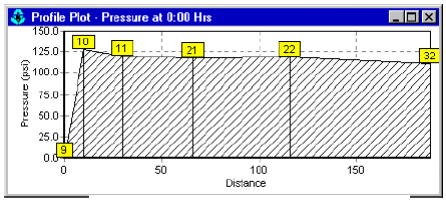
EPANET's water quality analyzer
Track the percent of flow from a given node reaching all other nodes over time

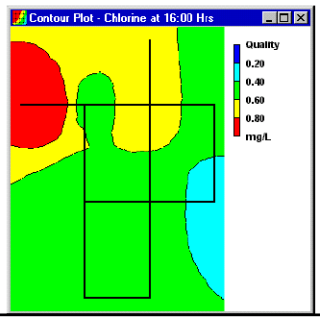


GRAPHICAL RESULTS









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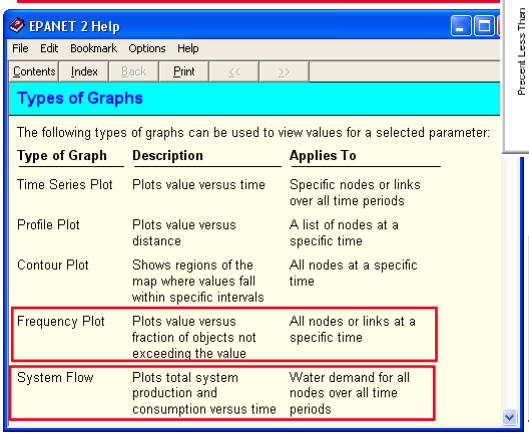
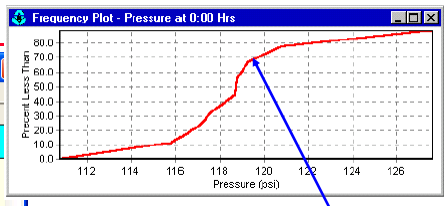
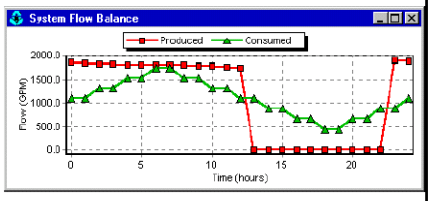
GRAPHS





70% nodes have pressure less than 120 psi



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EPANET TUTORIAL

- Great way to practice and learn
- Build a network from scratch
- Chapter 2, Page 13 of the Users Manual

CHAPTER 2 - QUICK START TUTORIAL

This chapter provides a tutorial on how to use EPANET. If you are not familiar with the components that comprise a water distribution system and how these are represented in pipe network models you might want to review the first two sections of Chapter 3 first.

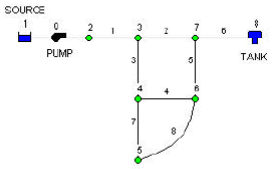

Figure 2.1 Example Pipe Network

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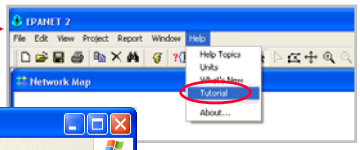
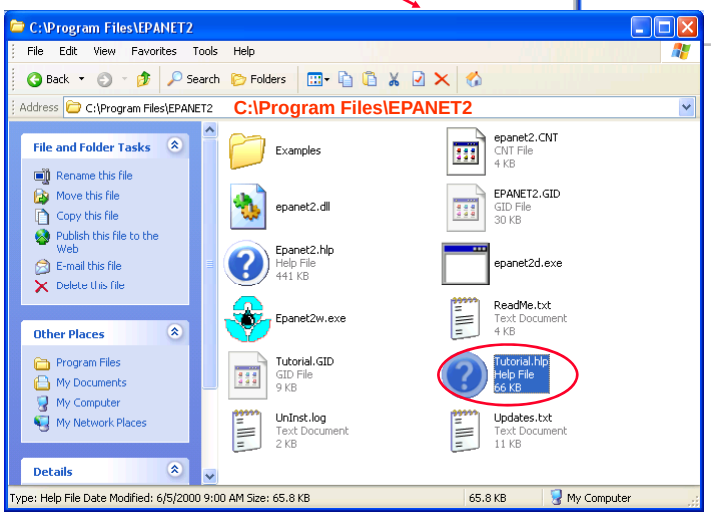
EPANET TUTORIAL

1. Select Tutorial from EPANET Help menu, or
2. Open Tutorial.hlp file from C:\Program Files\EPANET2





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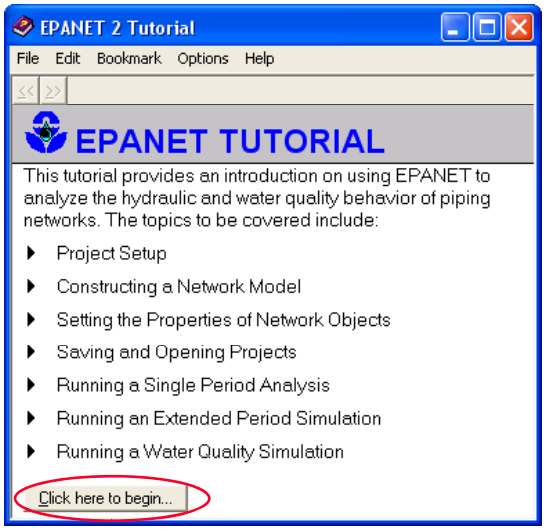
EPANET TUTORIAL



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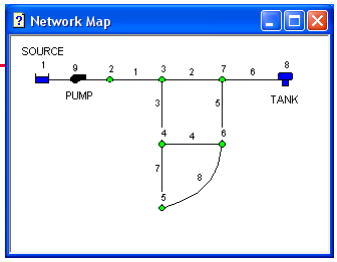
EPANET TUTORIAL



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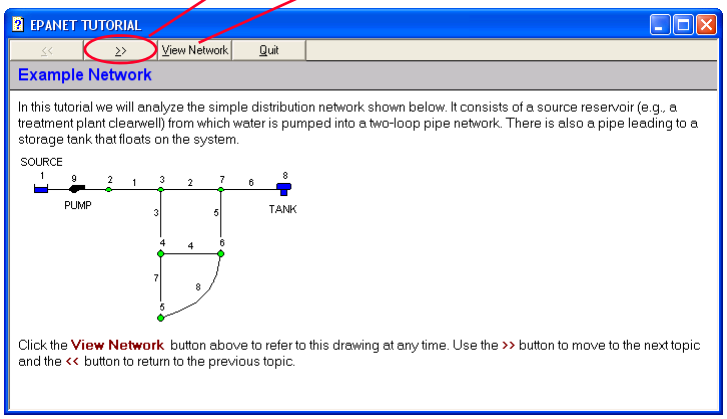

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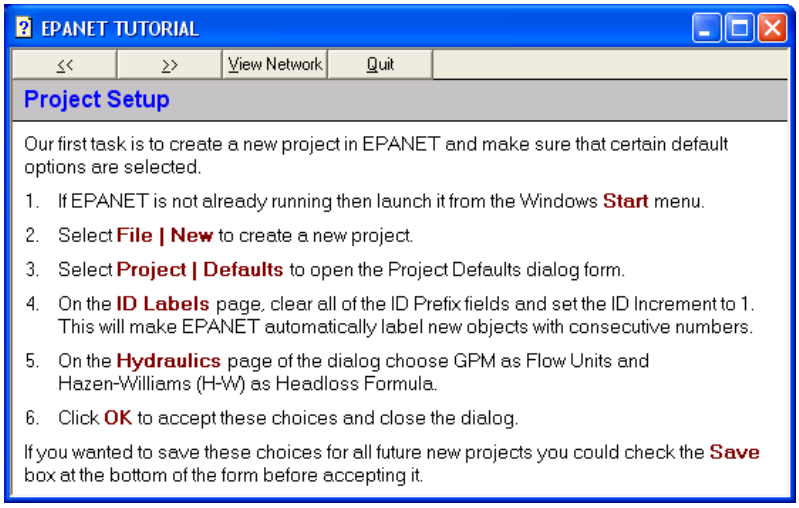
EPANET TUTORIAL



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EPANET EXAMPLES

- EPANET comes with three example pipe networks to help one become familiar with the program.
- The example input files are installed in the "Examples" folder underneath the EPANET 2 installation directory
  - C:\Program Files\EPANET2\Examples
- Examples include:
- net1.net: a simple pipe network modeling chlorine decay
- net2.net: an example of a tracer study utilizing calibration data
  - net2-FL.dat: calibration data used with net2.net
- net3.net: a larger network model illustrating source tracing
- View the Project Summary for example description (select Project >> Summary from the main menu)

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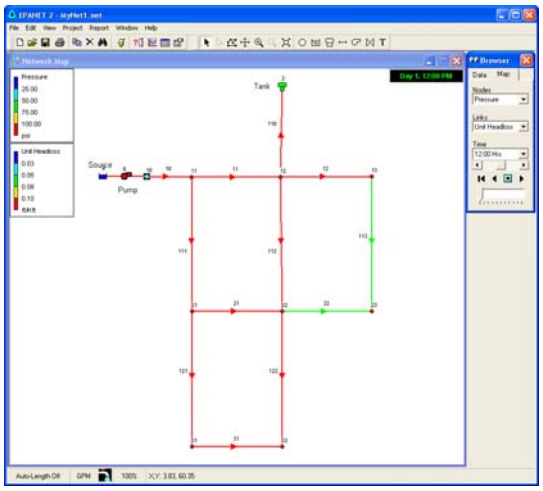
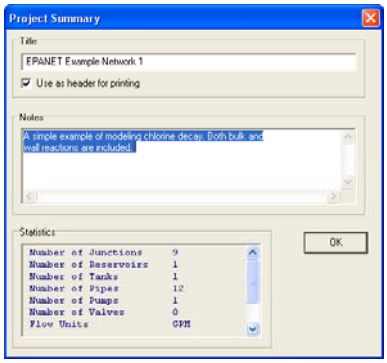
HOMEWORK 6: EPANET EXERCISE

- EPANET Example 1: net1.net
- A simple example of modeling chlorine decay





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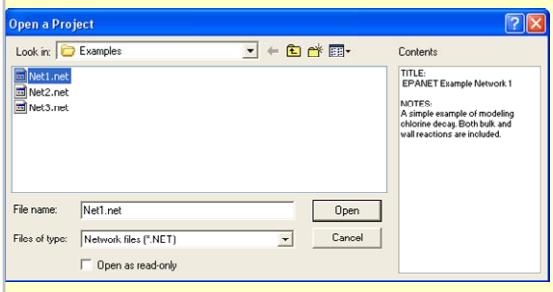
HOMEWORK 6: EPANET EXERCISE

- Download and print the exercise from the Course Web site (HW5.pdf)
- It has 20 steps.
- Exercise has questions that should be answered.
- Answer the exercise questions
- Submit the exercise with answers

HOMEWORK NO. 5: EPANET EXERCISE

CEEN 4800/6965 - Special Topics
Geographic Information Systems and Hydrologic & Hydraulic Modeling

- Launch EPANET software from Start → All Programs → EPANET 2.0
- From File menu select Open. Navigate to C:\Program Files\EPANET2\Examples folder if necessary. Select the EPANET input file Net1.inp and click open.



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