THE GREAT WATER HOOK-UP

Grades 7-12

➤ **OBJECTIVES**

- Build a model of a water delivery system from source to user.
- Explore factors that need to be considered when designing a water distribution system.

➤ **INTERDISCIPLINARY SKILLS**

Science, Social Studies, Mathematics, Economics

➤ **ESTIMATED TIME**

2 hours (may be spread over 2 days)

➤ **MATERIALS**

- ❑ Activity handout
- ❑ Large-diameter cardboard tubes (e.g., map tubes)*
- ❑ Medium-diameter cardboard tubes (e.g., wrapping paper tubes, toilet paper tubes, paper towel tubes)*
- ❑ Small-diameter tubes (rolled card stock or straws)*
- ❑ Ten boxes labeled: school (1 box); business (3 boxes); hospital (1 box); industry (2 boxes); new school (1 box); new business (1 box); new industry (1 box)

** If tubes are unavailable, roll up poster board or construction paper into different sizes. Tape or staple ends together.*

TEACHING STRATEGY

1. Label boxes before class begins. (Suggestion: A few weeks before you begin the project, ask the students to collect cardboard tubes and boxes for the water distribution system.)
2. Distribute copies of the activity handout. Tell the students that they are water system designers. They have been asked to go to Small Town, New England, to design a new public water supply system. They must decide how to link all the homes and businesses to the water source so that everyone can get the water they need.
3. Have the class work as a group to design the delivery system. At random, give seven students the seven boxes that are labeled "school," "business," "industry," and "hospital." Wherever the students place the boxes will be their location in Small Town, New England. Assume that the chairs or desks in the classroom represent homes. (Reserve the 3 boxes that represent new buildings.)
4. Randomly select a location for the well. (This will be the starting point for the model.)
5. To avoid chaos, provide a large pipe that leads from the well. Have students begin building the distribution system from that point.
6. After the system is designed, have students determine the cost of the entire delivery system.
7. Have students scrutinize the design to see if any changes can be made to reduce the cost. Ask students to calculate the amount of money saved as a result of any design changes.
8. Randomly distribute the boxes marked "new school," "new business," and "new industry." If necessary, redesign the water system, and determine the cost of adding in these new users. Tell students that before a large water user is added to the system, communities must check to be sure there is adequate water to serve them.

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9. After designing the water distribution system, help students develop a list of questions that community leaders should ask when designing a system. For example: How many homes, industries, schools, etc. must receive water? How much water do they need? How much water is available? Where will all the homes, businesses, industries, etc. be located? What will the system cost, and how will the community pay for it? How will the community change in the future? How can the community plan for these changes, and in the case of new industries, businesses, and schools, who should pay the costs?

10. Ask students what steps community leaders might take to reduce future costs (e.g., group similar types of users together [zoning], limit growth of the community).

NOTE: If this activity requires more than one class period, have students sketch the system at the end of each class and reassemble it when the class meets again.

Supplementary Activities

- Once the water distribution system is designed, discuss, as a class, how the community will pay for the system (e.g., loan, bond, one-time fee). Calculate the cost of the system for each user (assume the number of students in the class is the number of users), based on current interest rates (if appropriate). Negotiate a payment plan that is agreeable to your "water users." (This activity can used as a math/economics supplement.)
- If your community uses public water, have students research the water distribution system. Obtain a copy of the community's water distribution map(s) and invite your water supplier to come to class and discuss system planning, maintenance, and repair.
- Have the class add a wastewater collection system. Explain that Small Town is having problems with its septic systems and will soon need to build a wastewater treatment plant so that a wastewater collection (sewer) system can be hooked up to all the homes and businesses. Have students find a location where the wastewater can be treated and then discharged into a receiving river or stream. Figure out how to accomplish this great wastewater hook-up.
- Instead of using the piping costs provided in Part 2, relate the cost of the distribution system to the length of the system. To do this, have the students assign an overall scale to the piping system (for example, 1 inch = 10 feet). Based on this scale, assign a cost per linear foot of pipe (for example., $100 per foot (large), $50 per foot

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(medium), $25 per foot (small). You may even want to break it down further into separate installation and material costs. (Installation costs will be approximately the same per foot, whereas the larger pipe sizes will affect the materials cost per foot.) Have the students measure their proposed distribution system and then convert their results into feet and then into dollars.

Explain to the students that this is how real world construction costs are estimated. This type of exercise will help the students understand scales and conversions and, at the same time, add a planning component to the activity (e.g., the cost of developing away from the town center).

This activity is adapted from Massachusetts Water Resource Authority. *Water Wizards.* Boston: Massachusetts Water Resource Authority.

The Great Water Hook-Up

Background Information

Our **drinking water** comes from either ground water wells or surface water (e.g., river, lake, man-made reservoir). Ground water supplies are usually extracted by a pump, treated and disinfected when necessary, and delivered to homes and businesses through a network of pipes called a **distribution system**. Many people who live in rural areas have individual, on-site ground water wells with very simple piping systems; many other people who depend on ground water, but live in more populated areas, receive their water from large water supply wells through more complicated distribution systems.

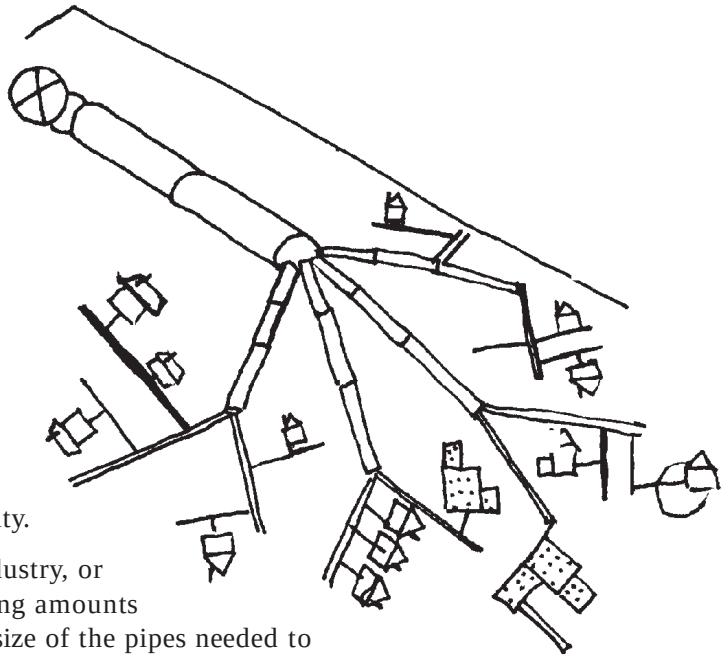
Surface water supplies are withdrawn from rivers, lakes, and reservoirs through large intake structures. The water is disinfected and often treated or filtered to remove impurities before entering the distribution system. Surface water supplies often travel through many miles of underground pipes before reaching the faucets of people's homes and businesses.

In the water distribution system, the size of the pipe is a function of the amount of water that will typically pass through it. Thus, the largest pipe hooks into the source water supply (e.g., ground water well, reservoir, river); middle-size pipes serve larger water users (e.g., office buildings, hospitals, apartment buildings); and the smallest pipes serve individual residences.

PART 1

Scenario

Small Town, New England needs help in designing a new water delivery system. It has asked your firm, Water Hook-Ups, Inc., to do the design work.



Job Specifications

- The community relies on a large well to provide water to its residents, businesses, and institutions and needs a system to pump and deliver water from the well throughout the community.
- Each home, business, industry, or institution requires varying amounts of water. Therefore, the size of the pipes needed to provide water also varies. (Larger pipes provide more water.)

- You must follow these rules when laying pipes:

  1. Large pipes must hook up to the well. Large pipes will be used for the major water lines running through the community.

  2. The hospital and the industry use a very large amount of water and must be connected to a large water pipe or be served by a couple of medium-size pipes.

  3. The businesses and school use a lot of water but not as much as the hospital and industry. They must be connected to a medium-size pipe.

  4. Homes use less water than businesses and require a small pipe.

  5. Pipes can be connected only in descending order. That is, from the well, large pipes are connected to medium-size pipes, which are connected to small pipes. Also, from the well, large pipes can be connected to small pipes. However, once you lay a small pipe, you cannot add a medium-size pipe or large pipe on the end. That would cause a bottleneck.

  6. A large pipe can serve 3 medium-size pipes or 15 small pipes. Each medium-size pipe can serve 5 small pipes.

  7. Consider the need for future maintenance and repairs. If a section of pipe must be closed for maintenance, consider how you will provide water to the affected users (e.g., a loop versus a dead-end system).

Part 2: Your Job

ASSIGNMENT

1. Connect the pipes! Be sure that every home, business, industry, school, and hospital will receive water.

2. When you are done laying pipes, determine the cost of the project based on the following cost figures:

Large pipe = $15,000 each
Medium pipe = $ 5,000 each
Small pipe = $ 1,000 each

▶ Follow-up Questions

- How much did the whole delivery system cost?

$ _____

Part 3: Delivery System Changes

1. Look at the delivery system you designed. Can you make any design changes to reduce the cost?

a. If so, briefly list those changes.

_____

_____

b. What is the cost of the redesigned system?

$ _____

c. How much did you save

$ _____

2. Help! Small Town is growing rapidly. The town wants to build a new school, a new business, and a new industry. (Your teacher will tell you where they are located.) Make changes in your design to serve these new needs.

a. How much did the changes cost?

$ _____

b. Who do you think should pay for those changes? Support your reasoning.

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KEY TERMS

- **Distribution System**
- **Drinking Water**

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