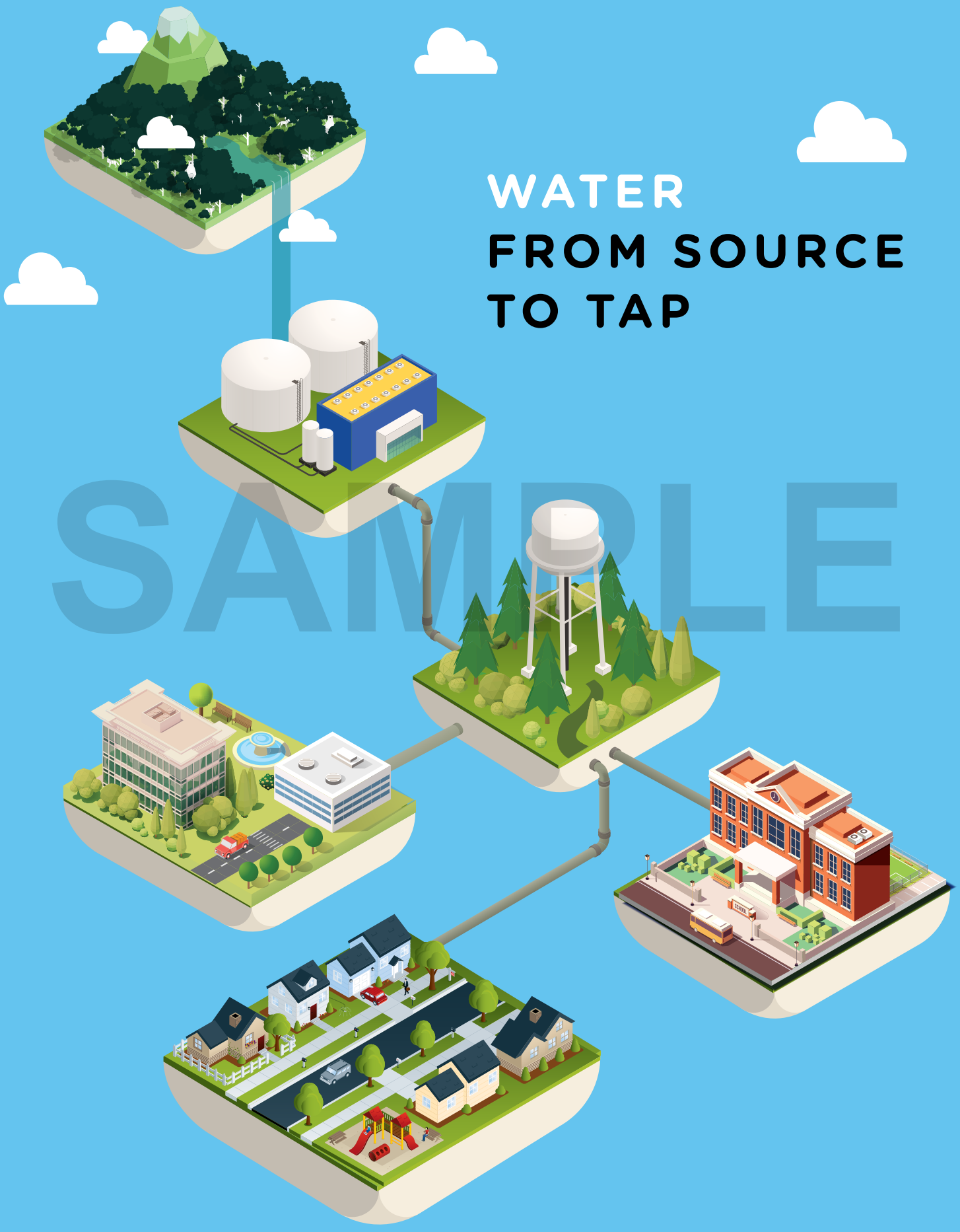
WATER
FROM SOURCE TO TAP



WATER IS EVERYWHERE!

Water is essential for all known forms of life, whether they are plants, animals, or microorganisms. In our daily lives, water plays an important role in almost everything we do. We drink water. We use it to cook our food and to clean up after ourselves. It's used in agriculture to grow food and in industry to cool down machinery.

Clean, drinkable water doesn't just magically appear in our faucets. It requires lots of effort from water workers who protect water sources, run water treatment plants, maintain pipes, and handle dozens of other responsibilities to ensure we have a safe, reliable supply of drinking water. This book is about the work required to get water to your home and what you can do to conserve water in your daily life.

IS THERE WATER IN SPACE?

Scientists who are looking for aliens might start by looking for water. This is because water plays an essential role in sustaining life as we know it. If scientists find water on another planet or moon, it might mean that planet or moon is capable of sustaining life.

Scientists begin looking for planets that could sustain life by identifying the "habitable zone" in a solar system. That's the range in which the planets aren't so close to the star that it's too hot to sustain liquid water or so far that it's too cold for liquid water. In our solar system, Earth is the only planet with liquid water on its surface.

Water isn't just important for us; it's important for finding new friends in space too!

HOW WATER GETS TO YOU

Turn on the tap, and you'll have water at your fingertips—but how does it get there?

Public water systems draw their water from one or more sources. Typically the local water system will draw its water from a local lake, river, or reservoir (a man-made lake, often created by damming a stream, that provides a steady water source throughout the year). It may also pull its water from groundwater (water that lives underground in the tiny spaces between soil and rocks).

From there, the water needs to be cleaned and treated so it's safe to drink. So what does that look like? The exact treatments will vary depending on the source and where you live, but here are the basics:

THE SAFE DRINKING WATER ACT

The federal Safe Drinking Water Act was enacted in 1974. It created a national health-based standard for the public drinking water supply. It also established a set of actions public water systems must follow to protect drinking water and its sources: rivers, lakes, reservoirs, springs, and groundwater wells.

COAGULATION

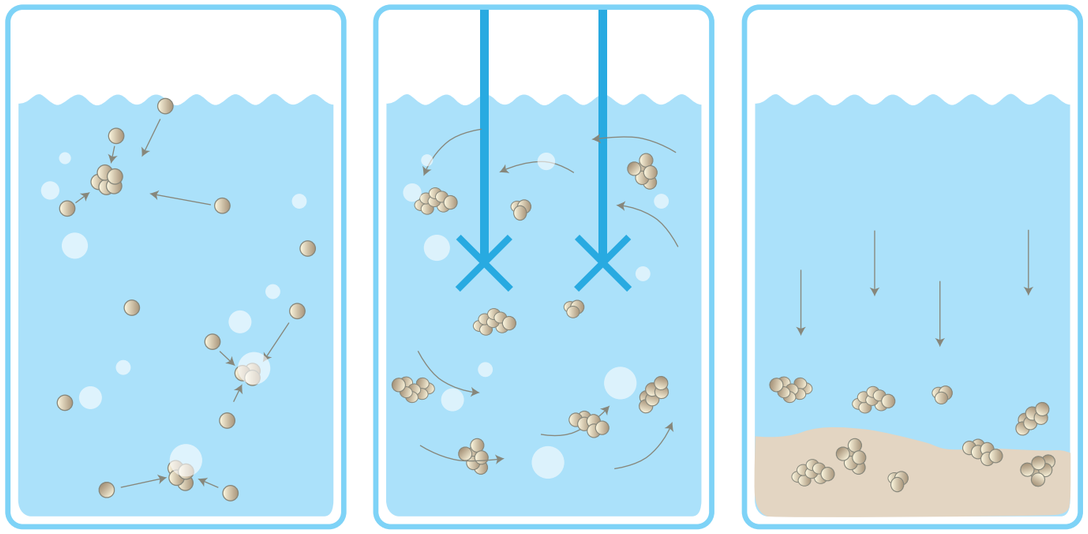
To take the gross stuff out of drinking water, the first step is to ADD stuff to it! Chemicals with a positive charge are added to the water, which neutralizes the negative charge of dirt and other particles that may be hanging around. That makes these particles bind together.

FLOCCULATION

After coagulation gets these unwanted particles to stick together, next is flocculation, aka mixing to form larger, heavier conglomerates called "flocs." Some treatment plants add chemicals to help form the flocs.

SEDIMENTATION

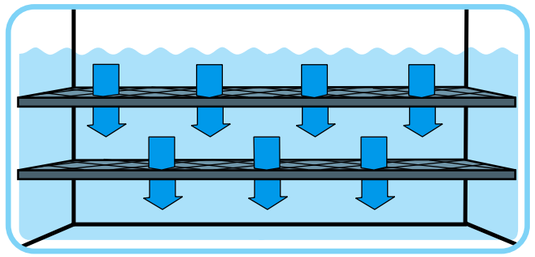
Now that the treatment plant has gotten the unwanted stuff in the water to stick together in flocs, it's time to get that debris out. Sedimentation helps separate the solids from the water by letting those heavy flocs sink to the bottom.



FILTRATION

The remaining floc-free water now goes through a filtration setup to remove smaller unsavory solids by passing the water through a series of filters with different pore sizes and made of different materials, such as sand or charcoal.

This removes anything that the coagulation process missed, such as parasites, dust, or metals. Some filters, such as activated carbon filters, can remove bad odors, while reverse osmosis can take care of dangerous metals such as arsenic.



DISINFECTION

After all these steps, it's still possible for bacteria and other pathogens to sneak through. Treatment plants disinfect the water by adding chlorine, chloramine, or chlorine dioxide to kill off any lingering germs. (Some treatment plants even use UV light and ozone to kill off germs in the water while it's at the plant.) With chlorine-based treatments, a small amount of this disinfectant is still present in the pipes as the water travels to your home so that any other bacteria that come into contact with the water won't spread.

FINISHING TOUCHES

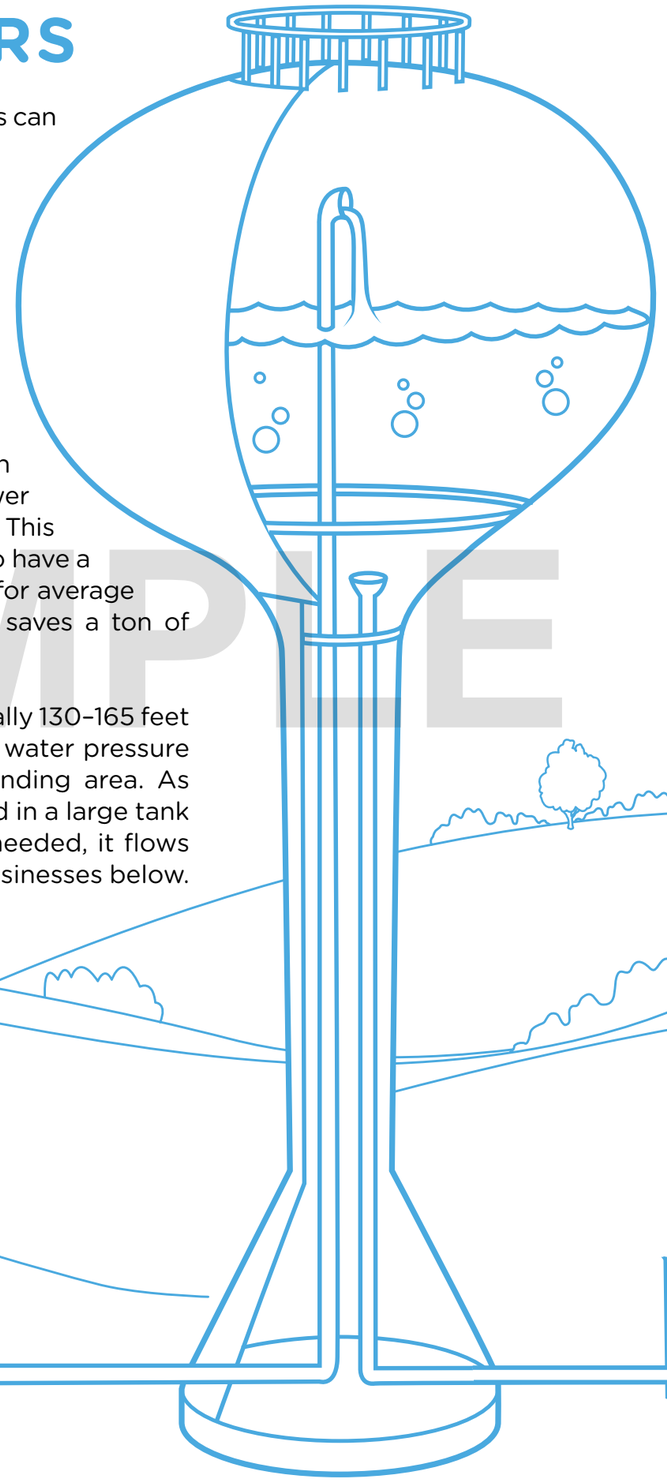
After these health-related treatments, many plants adjust the water's pH (level of acidity). This can help improve the water's taste and reduce corrosion of the pipes that carry water to the community. As a final flourish, plants add fluoride to help keep people's teeth strong and healthy. Good-tasting water AND no cavities: a win-win!

WATER TOWERS

Water towers are big! Some of these giants can hold more than a million gallons of water.

Many water systems utilize water towers to ensure they have consistent and reliable water for their community. The tank of a water tower is usually sized to hold about a day's worth of water in case the municipal pumps fail (such as during a power outage). It also can supplement the municipal system, so if the community demands more water than the pump can supply, the water in the tower will automatically help meet the need. This means that the municipality is less likely to have a water shortage and it can size its pumps for average demand rather than peak demand—this saves a ton of money in the long run.

Water towers are elevated structures usually 130–165 feet tall. Water towers use gravity to provide water pressure to homes and businesses in the surrounding area. As water is pumped into the tower, it's stored in a large tank at the top of the tower. When water is needed, it flows down through pipes to the homes and businesses below.



BUT WHY ARE THEY SO HIGH UP?

The height of the water tower is crucial because it determines how much potential energy the water has. When water is stored high off the ground, it has more potential energy, like a ball at the top of a hill. Just as a ball picks up speed as it rolls down a hill, this potential energy allows the water to flow downward through pipes and into buildings when people open their faucets. Without this height and the resulting potential energy, it would be challenging to deliver water to locations that are far from the source or to upper floors in buildings.

In addition to providing water pressure, water towers also help regulate the water supply by balancing out fluctuations in demand. During times of low demand, water is stored in the tower for later use. During times of high demand, water is pumped into the tower to ensure a steady water supply to the area.

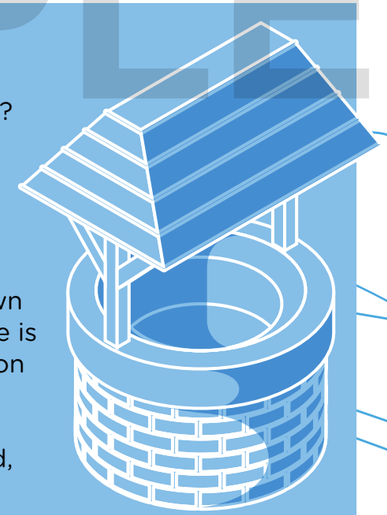
Overall, water towers are an important component of public water supply systems, providing reliable water pressure and helping to ensure a consistent supply of water to homes and businesses.

WELL, WELL, WELLS...

But what if you're not on a public water system?

Some households will drill into groundwater aquifers and tap into this relatively clean water source directly.

To tap into the aquifer, a borehole is drilled down into the water table. Inside this cylindrical space is the well casing, a long tube made of PVC, carbon steel, or stainless steel, to keep the water from being contaminated by the surrounding soil. A screen sits on the bottom to help filter out sand, gravel, and other solid particles.



PUMPING STATION

BACKFLOW PROTECTION

WATER TOWER MATH

Building a water tower that meets the local community's needs requires planning and math! Where the water tower should be located, how big the water tower needs to be, and what measures can be taken if it needs to serve a larger community must all be worked out. Solve the problems below to understand what kind of water tower is needed to address each situation.

1. A water tower supplies water to a neighborhood with 300 houses. If each house uses 300 gallons of water per day, how much water does the water tower need to supply the entire neighborhood for one week?

2. A water tower has a capacity of 200,000 gallons. If it's filled to 60% of its capacity and each person in the community uses an average of 20 gallons of water per day, how many people can the water tower support for one day?

3. A water tower can distribute 300,000 gallons of water per day. If a hospital requires 4,000 gallons per day and there are 15 hospitals in the area, how much of the capacity of the tower will be left for the rest of the community?

4. The water tower supplies water to a town with 8,000 residents. If each resident uses an average of 20 gallons of water per day, how much water does the town need from the water tower in a 30-day month?

5. A water tower is being upgraded to increase its capacity by 25%. If the current capacity is 300,000 gallons, what will the new capacity of the water tower be after the upgrade?

6. A water tower has a capacity of 475,000 gallons and is currently filled to 70% of its capacity. How much additional water does the water tower need to store to reach its full capacity?

7. A water tower has a capacity of 130,000 gallons. If a house uses 25 gallons of water per day, how many houses per day can be supplied by this water tower?

8. The town from question 7 adopts new water conservation standards, so now 1,300 more houses can be supplied by the same 130,000-gallon water tower. How much water does each house use per day?

Answers on back cover

WATER CONSERVATION

Now that you know how much work goes into getting water to your home, it's important to use that water wisely. Here are 10 things you can do to save water at home.

1. Take short showers instead of baths: A bath uses about 70 gallons of water, but a 5-minute shower uses only 10 to 25 gallons.

2. Keep a container of drinking water in the fridge: You won't have to run the tap every time you want a drink of cold water.

3. Don't hose down the driveway, garage, or sidewalk: Use a broom instead.

4. Check the weather before you water your lawn: There's no reason to water if it's going to rain.

5. Check your garden hose for leaks: If it leaks at the connection to the spigot, replace the hose washer and wrap the threads with pipe tape.

6. Wash full loads: The washer fills up with water whether it contains one item or a full load.

7. Don't let the water run: To clean fruits or vegetables, put them in the sink or in a pan and fill it up with water. You could save 50 to 100 gallons of water per month.

8. Don't run the water while you brush your teeth: Turn on the water only when you need it.

9. Fix leaks: One drop per second wastes more than 3,000 gallons of water a year!

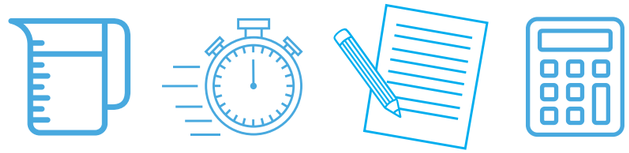
10. When buying new water appliances, look for the WaterSense Label.

FLOW RATE INVESTIGATION

How much water do you use to take a shower or wash a dish? To answer that, you need to know the flow rate of your shower or sink. Simply put, the flow rate is how fast water comes out of the faucet or tap. You can calculate it as the volume of water flowing per unit of time—for example, gallons per minute. Try the activity below to calculate the flow rate of your shower nozzle or the faucet of your bathroom or kitchen sink.

MATERIALS NEEDED:

- Measuring container (e.g., a bucket marked in liters or gallons)
- Stopwatch or timer
- Pen and paper for notes
- Calculator



PROCEDURE:

1. Measuring Shower Flow Rate:

- Place the measuring container under the showerhead.
- Turn on the water and adjust it to the typical pressure.
- Time how long it takes to fill the container to a specific volume (e.g., 1 liter or 1 gallon).
- Record your findings and any notes in the provided chart.
- Calculate the flow rate using the formula V/T=Q.
  V is volume, T is time, and Q is the flow rate. So if a 1-gallon bucket took two minutes to fill, the flow rate would be .5.
- If your showerhead has other settings, try them and see if the flow rate is the same.

2. Measuring Faucet Flow Rates:

- Repeat the same procedure with the bathroom or kitchen faucet.

Location	Volume of container (V)	Time to fill container (T)	Calculated Flow rate (Q)	Notes
Example: Shower	**1 Gallon**	**2 mins**	**.5**	**Average setting**

Follow-up question.
Time yourself in the shower to see how long it takes. Now you can figure out how much water you use in the shower by multiplying the flow rate and the time. Consider reducing your shower time by 2 minutes. How much water would you save?

SAVE WATER, SAVE ENERGY!

Water utilities use a lot of energy to pump, clean, and deliver water to your home. Why should you care? Because utilities pay for that energy, and part of your water and sewage bills are actually energy bills.

That's not all. Your family pays twice for much of your water—once for the cost of the water itself and once for the cost of heating it. It can add up quickly. Using less water doesn't just save water; it can save energy too. When you take a hot shower or run the dishwasher or washing machine, you pay two prices: one for the water and another to heat the water and run the appliance. Combined, the costs can add up.

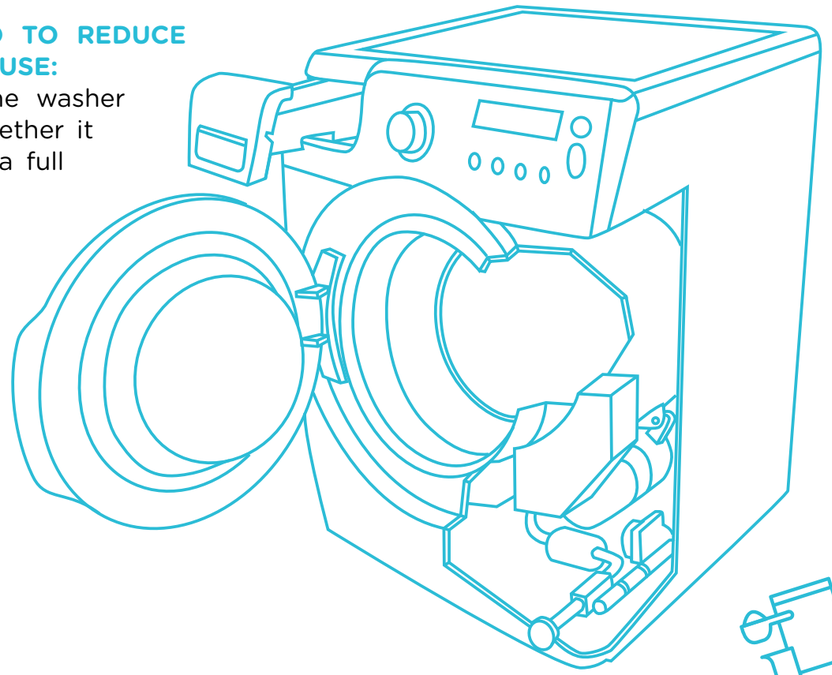
The good news is there are lots of no- and low-cost ways to save water throughout your home.

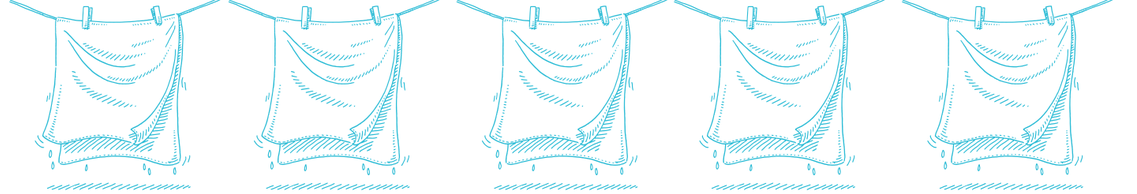
WASHING MACHINE: A washing machine is your handy laundry assistant that uses water and energy to clean your clothes. When you load your dirty clothes into the machine and start a wash cycle, the washing machine fills up with water from your home's water supply. This water is mixed with detergent to create a soapy solution. Then, the machine's agitator or drum starts to move, and that's where the magic happens! The clothes are swished around in the soapy water, and this motion helps to remove dirt and stains. Meanwhile, the machine's heating element, similar to the one in your water heater, warms up the water if you selected a warm or hot water wash cycle, which is especially effective for getting rid of tough stains. Once the washing is done, the machine drains the dirty water and refills with clean water for the final rinse. After all this, your clothes are clean, thanks to the combination of water and energy used by the washing machine!

WHAT YOU CAN DO TO REDUCE WATER AND ENERGY USE:

- Wash full loads: The washer fills up with water whether it contains one item or a full load.

- Use cold water: You'll save money because you're not paying to heat the water. Use hot water only for very dirty loads.





"TOWEL TALLY" AWESOME WATER SAVINGS!

Everyone needs to shower, so everyone needs to use a towel, and when they get dirty, towels need to be cleaned. Reusing your towel can save a lot of water. Let's calculate the savings.

First, let's figure out how many loads of laundry are done in a month in a household with four people if each person uses a new towel every day versus using a towel for 7 days and the washing machine can hold 8 towels.

Towels per week	(x) People in the house	(x) Weeks per month	(=) Number of dirty towels	(/)Towels per laundry load	(=) Number of laundry loads
7	x4	x4			
1	x4	x4			

There are two types of washing machines: top loading and front loading. Front loaders use less water, so they're better for the environment. Let's now calculate how much water you use to do this laundry, comparing the top-loading and front-loading washers. The top-loading washer uses 35 gallons per load, and the front-loading washing machine uses 25 gallons per load. Input your calculated number of laundry loads from the above table into the third column of the table below:

Type of Washer	Towels per week	Number of laundry loads	(x) Gallons per load	(=)Gallons in a month	(x) Months in a year	(=) Gallons in a year
TOP LOADING	7				12	
	1				12	
FRONT LOADING	7				12	
	1				12	

For reference, a hot tub holds around 500 gallons of water. How many hot tubs' worth of water would you save a year if you used one towel a week rather than seven?

Answers on back cover

CAREERS IN WATER

When we turn on the faucet to get a glass of water, we don't usually stop to think about the professionals in the water industry who keep us and our environment safe. If you're seeking a career path that's stable, in demand, and recession proof, the water industry might be for you! Here are some examples of jobs in the wonderful world of water.

WATER TREATMENT PLANT OPERATOR

Water treatment plant operators work with freshwater sources, such as wells, rivers, streams, and reservoirs, and are responsible for testing, treating, and monitoring the water. Before water travels to homes, schools, and businesses, it passes through a water treatment plant to ensure that it's safe to drink. Operators add chemicals as necessary to disinfect the water and to clean and maintain equipment to ensure safety. In addition, these operators use computers and other machinery to control and operate the processes used to treat our drinking water.

LABORATORY TECHNICIAN

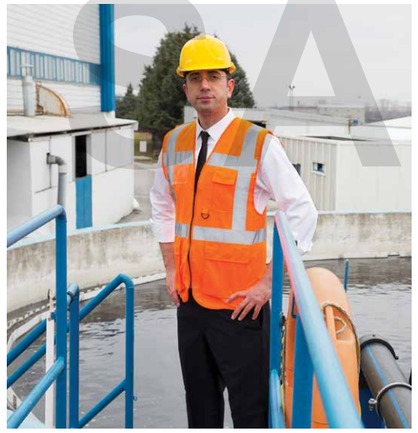
Laboratory technicians help ensure that our water is safe to drink. To do this, they have to run tests and analyze the results. Compliance testing is used to determine whether treatment processes are in compliance with regulations and to ensure the water is free of contaminants. This position is primarily lab based. These technicians support governments, water treatment plants, hydrologists, and other environmental scientists and agencies.

PLUMBER

Plumbers install, maintain, and repair the pipes that supply water and gas to our homes and businesses and that are responsible for drainage, irrigation, sewage, and various other functions as well. Plumbers can install and repair plumbing fixtures, such as bathtubs, showers, sinks, and toilets, as well as some appliances. On top of that, they can clear obstructions from sinks, bathtubs, and toilets. Some plumbers work in a design capacity, which involves drafting blueprints to help increase the efficiency of the installation process.

UTILITY MANAGEMENT

Utility managers and supervisors are the captains of the ship—metaphorically speaking, of course. Employing effective leadership skills, these leaders ensure that what needs to get done is done. They provide their fellow employees with a clear idea of their organization's strategic goals and operational priorities. Upper management is also responsible for coaching and developing their employees through regularly scheduled trainings and feedback sessions and for fostering a healthy company culture.



WASTEWATER TREATMENT OPERATOR

Wastewater treatment operators are in charge of removing pollutants from the water used for domestic and industrial purposes. Their goal is to sanitize water sourced from sewers and drains before releasing it or allowing it to be used for irrigation. Operators split their time between indoors and outdoors and work with chemicals, computers, and machinery. Wastewater treatment is vital to public health; it makes it possible for us to safely use our streams and rivers for swimming, fishing, and drinking.

ENVIRONMENTAL ENGINEER

Environmental engineers research, design, plan, and implement processes, using their extensive knowledge of the sciences and engineering, to help with the prevention, control, and remediation of environmental hazards. They aim to control issues related to waste treatment, pollution control technology, and site remediation. These engineers also study the existing or potential environmental impact of land use projects on water. Depending on what kind of project they're working on, engineers may find themselves out in the field or in an office.

CONTINUE LEARNING ABOUT WATER

We hope that reading this booklet is just the start of your interest in water distribution and conservation. Here are some resources to help you as you continue looking into this topic.

US ENVIRONMENTAL PROTECTION AGENCY

WWW.EPA.GOV/WATERSENSE

CENTERS FOR DISEASE CONTROL AND PREVENTION

WWW.CDC.GOV/HEALTHYWATER/DRINKING

WATER TOWER MATH ANSWER KEY

1) 300 houses × 300 gallons per house per day × 7 days in 1 week = 630,000 gallons per week

2) (200,000 gallons × 0.60) = 120,000 gallons ÷ 20 gallons per person per day = 6,000 people

3) 300,000 gallons – (15 hospitals × 4,000 gallons per hospital per day) = 240,000

4) 8,000 residents × 20 gallons per resident per day × 30 days = 4,800,000 gallons

5) 300,000 gallons + (300,000 gallons × 0.25) = 375,000 gallons

6) 475,000 gallons - (475,000 gallons × 0.70) = 142,500 gallons

7) 130,000 gallons ÷ 25 gallons per house per day = 5,200 houses

8) 130,000 gallons ÷ (5,200 + 1,300 houses) = 20 gallons

"TOWEL TALLY" AWESOME WATER-SAVINGS ANSWER KEY

Towels per week	(x) People in the house	(x) Weeks per month	(=)Number of dirty towels	(/)Towels per laundry load	(=) Number of laundry loads
7	x4	x4	112	8	14
1	x4	x4	16	8	2

Type of Washer	Towels per week	Number of loads	(x) Gallons per load	(=) Gallons in a month	(x) Months in a year	(=) Gallons in a year
TOP LOADING	7	14	35	490	12	5,880
	1	2	35	70	12	840
FRONT LOADING	7	14	25	350	12	4,200
	1	2	25	50	12	600

For reference, a hot tub holds around 500 gallons of water. How many hot tubs' worth of water would you save a year if you used one towel a week rather than seven?

TOP LOADING: (5,880/500)-(840/500)=10 HOT TUBS

FRONT LOADING: (4,200/500)-(600/500)= 7 HOT TUBS