

# HYDROPOWER

SCIENCE AND SAFETY



**investigate** **PROTECTING LOCAL WATERWAYS**



**HOW WATER IS USED TO MAKE ELECTRICITY**

**discover**



**learn** **YEAR-ROUND WATER SAFETY TIPS**



# water in your world

## WATER IS A SCARCE AND VITAL RESOURCE

Fresh, clean **water** is essential for life and is one of our most precious resources.



While the majority of the earth is covered by water, it is mostly salty and undrinkable ocean water. Only about **3%** of all the planet's water is fresh water. Most of this is frozen in glaciers, so it's not possible for us to use it. That leaves about **1%** of all water on earth available for drinking and other activities.



### ACTIVITY: Chart the Earth's Water

Use the information below to make a pie chart that shows the following:

- **96%** of water on earth is salty and undrinkable.
- **3%** of water on earth is fresh water.
- **1%** of water on earth is available for human use.

### ACTIVITY: WATER WORDS

Write the page number(s) where each one of the following water vocabulary words appears. With a partner, share the work of looking up definitions for the words. These and other new water words are highlighted in **orange** in this booklet.

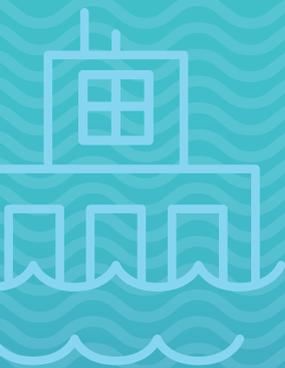
canals \_\_\_\_\_ transpiration \_\_\_\_\_ evaporation \_\_\_\_\_

flumes \_\_\_\_\_ dams \_\_\_\_\_ percolates \_\_\_\_\_

pollutants \_\_\_\_\_ buoys \_\_\_\_\_ runoff \_\_\_\_\_

condensation \_\_\_\_\_ reservoirs \_\_\_\_\_ electromagnets \_\_\_\_\_

precipitation \_\_\_\_\_ watershed \_\_\_\_\_ electrons \_\_\_\_\_



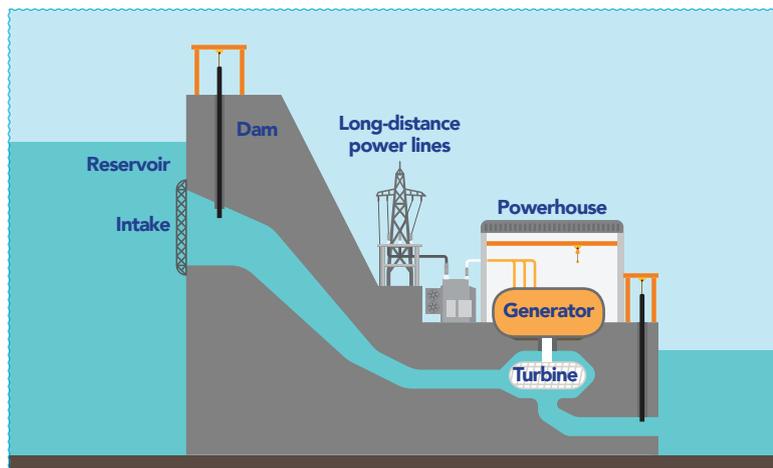


# the power of water

Flowing water is a form of mechanical energy that can be used to produce electricity. This is called "**hydropower**." Hydropower relies on the movement of water to turn turbines. The turbines turn **electromagnets** that consist of heavy coils of copper wire. The moving magnets cause the **electrons** in the copper wire to flow from atom to atom, generating electricity.

Hydropower is the largest source of renewable energy in the United States. It is produced in every state in the country, at several different types of hydropower facilities. These include:

- **Hydropower Dams.** A dam is used to raise the water level of a river and create a reservoir. Water in the reservoir builds up pressure against the dam, and can be released into a powerhouse, where it spins a turbine to create electricity.
- **Dams with Pumped Storage.** When demand for electricity is low (such as at night), water that has been used to create electricity can be pumped back up through the dam to the reservoir, where it is stored for future use.
- **Run-of-the-River Hydropower.** A large pipe called a penstock carries water from a river downhill to a powerhouse, where the force of the water spins a turbine to create electricity. Then the water is returned back to the river downstream.



Does your local energy provider deliver electricity that is generated from hydropower? If so, where are the hydropower facilities located? Do some Internet research to find out.

## ACTIVITY: MEGAWATT MATH

The electricity we use in our homes is measured in watts. For example, light-emitting diode (LED) bulbs use between 5 and 28 watts. A hair dryer uses about 1500 watts.

Because power plants generate so much electricity, the electricity they make is measured in much larger units called megawatts. One megawatt equals one million watts.

- The largest hydropower facility in the U.S., the Grand Coulee Dam on the Columbia River in Washington state, produces up to **6,809 megawatts** of electricity.
- The Hoover Dam on the Colorado River that runs through Nevada and Arizona can produce up to **2,080 megawatts** of electricity.
- How many more **megawatts** can the Grand Coulee Dam produce than the Hoover Dam? \_\_\_\_\_

**Think about it:** About half of the hydropower in the U.S. is produced in the Pacific Northwest. Why do you think that is?

### FUN FACT

Humans have been harnessing the energy of flowing water for thousands of years. The ancient Greeks used water wheels to grind wheat into flour and to saw wood. Today, hydropower is the world's largest renewable source of electricity.

# energy and the environment

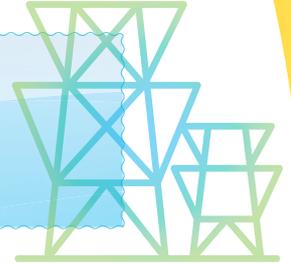


Much of the electricity used in the U.S. is generated from fossil fuels such as coal, oil, and natural gas. Producing and using fossil fuel-based energy releases pollution, greenhouse gases such as carbon dioxide (CO<sub>2</sub>) and methane, and other by-products into the environment.

Hydropower and other renewable resources, such as wind and solar power, are sometimes known as "green energy" because they do not release CO<sub>2</sub> or pollution into the atmosphere when used to generate electricity. However, green energy sources may affect the environment in other ways.

## 1. RESEARCH: Green Energy

Here are some green energy resources (other than hydropower) that help generate electricity: solar, wind, geothermal, biomass. Circle one you would like to learn more about.



## 2. Do some Internet or library research to answer these two questions for the energy resource you circled. Use the example below for hydropower as your model.

- How does using this resource to generate electricity benefit the environment?

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- How does this resource pose challenges to the environment?

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### Hydropower Benefits

- Using hydropower to generate electricity produces no CO<sub>2</sub> emissions and no air pollution.
- Dams create reservoirs that store water. They also make good locations for camping, swimming, and fishing.

### Hydropower Challenges

- Dams can prevent fish from swimming up rivers to spawn or back to the ocean after breeding. This can reduce fish populations. (Features like fish ladders can help).
- Reservoirs, dams, and **canals** can pose drowning risks to people who are not careful.

Learn how YOU can be safe on the next page! ►

# play it safe in the water



Many hydropower reservoirs, dams, rivers, and streams have nearby recreation areas. These include campgrounds, hiking trails, picnic spots and areas for fishing, swimming, boating, and other water sports.

## Always follow these Top 10 Tips for Water Safety:

1. **Be aware** that swimming in open water is not the same as swimming in a pool, as water conditions can change quickly.
2. **Obey all warning signs** and restrictive **buoys**.
3. **Use the buddy system**. Never fish, swim, boat, or raft alone.
4. **Don't dive or jump into unfamiliar or shallow water**. Submerged trees or rocks can cause serious injury.
5. **Wear a properly fitted U.S. Coast Guard-approved life jacket** in and around water at all times.
6. **Check the water** before you go in. How cold is it? How fast is it flowing?
7. **Do not enter the water** if it is too cold.
8. **Be alert for swift flows** and changing conditions.
9. **Never enter water unsupervised**; make sure an adult can see you at all times.
10. **Make a plan with your family** so that everyone knows the signal for getting out of the water at a moment's notice.



## ACTIVITY: Make a Water Safety Plan

Circle the water sports below that you have done or would like to try someday:

- Swimming
- Inner-tubing
- Canoeing
- Fishing
- River rafting
- Waterskiing
- Boating
- Kayaking
- Snorkeling

For each water sport that you have circled, list the following:

1. One way it can be dangerous:

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2. Two steps you can take to do this sport safely and reduce your risk of injury:

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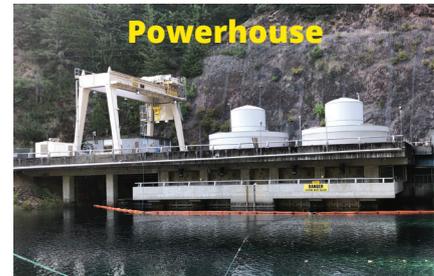
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# dam and canal safety

## Stay away from hydropower dams and powerhouses

- **Don't swim, boat, or play near a dam or powerhouse.** Swift currents of water can be released from dams and powerhouses at any time. These areas may also have slippery surfaces and submerged hazards.
- **When hiking or fishing near a powerhouse, stay alert for caution signs,** strobe lights, and/or sirens announcing an increase in water levels. If you see or hear a warning, move quickly to a safe area.



## Stay out of hydropower waterways

**Canals and flumes** move water from one part of the hydropower system to another. If you live in the vicinity of a hydropower system, you may even have one in your neighborhood!

**Never enter a canal or flume for any reason.** The water is cold and swift and the walls are slippery, making it very hard to get out.

### Use the following tips to stay safe:

- **Obey all warning signs.**
- **Never play or swim on, near, or in a canal or flume.** The water might appear calm, but it is icy cold and extremely powerful.
- **If you drop a personal article in a canal or flume, leave it.** Retrieving it is not worth the risk!



## ACTIVITY: REFUSE A DARE

With a partner, come up with at least four ways to say "NO!" if someone dares you to do something unsafe near water. Practice saying your **NO** statements loudly and clearly to each other.

**Bonus:** Has someone ever dared you to do something you knew was dangerous? If so, write a paragraph about it. **Include at least one sentence for each of the following questions:**

- **What was the dare?**
- **How did you react, and what happened?**
- **Are you satisfied with how you reacted to this dare? If not, how do you wish you had handled it?**

If you've never been dared to do something dangerous, use your imagination and write a scene about one kid daring another to do something.



# river and stream safety

Heavy rains, melting snows, or the sudden startup of electric hydropower generators can change a slow stream to a raging river in minutes. And although dams and reservoirs are very safe, an emergency is always possible.

When you're around rivers and streams that are part of a hydropower system, you must understand emergency warning signs. **Listen and watch for these signs of rising water levels:**

- **Increasing sounds of rushing water.**
- **Previously exposed rocks, sticks, and brush that are suddenly covered with water.**
- **Water flowing faster or deeper.**
- **Increasing debris in the water.**
- **Changed appearance of water from clear to muddy.**
- **Colder than expected water temperatures—even on the warmest days.**
- **Warning lights and sirens coming from a powerhouse.**



**If you notice any of these warning signs, get out of the water and/or move far from the water's edge immediately. Remember that extra water can temporarily flood roads and trails.**



## ACTIVITY: MAKE A DANGER SIGN

Create an illustrated danger sign for a hydropower reservoir, river, dam, or canal.

Your sign should do two things:

- 1) Explain a danger, and
- 2) Encourage others to practice one or more safe behaviors.

Here are two examples:

- Rising water levels can be deadly. If you hear loud rushing water, get out quickly!
- Canals are slippery. People and pets: Keep out!



# water emergency!

## If you are swept off your feet or trapped in rising waters:

- Stay calm and try to control your breathing; do not gasp, or you could swallow water.
- Keep your head above the water.
- Call loudly for help.
- Remove your shoes and drop any items that could weigh you down.
- If you are near a boat, stay with it. Hold onto the boat if you can.
- If you are in a waterway, get to the side and cling to a ledge, crack, or low branch until help arrives. If you cannot find a ledge, crack, or low branch to hold onto, reach for the branches of an overhanging tree.

## If you cannot get to the side, stay calm and take the following steps:

- Float downstream on your back.
- Keep your feet up and pointed downstream to avoid hitting rocks.
- Move diagonally across the current until you reach shore, then roll onto dry land.

## If you witness someone else in a water emergency:

- Call loudly for help. Do NOT enter the water to try and rescue them.
- Tell the person to try to get to the side and hold on until help arrives.
- If you have a cell phone, call 911. You will be asked the following questions:
  1. What is your emergency?
  2. Is the victim conscious or do they appear not to be breathing?
  3. What is happening now?
  4. What is your location?
  5. What phone number are you calling from?
- Stay where you are until help arrives.

## If a pet falls into swift-moving water:

Do NOT try to rescue it. You could put yourself in serious danger. Instead, shout for help, call 911, and stay where you are until help arrives.



### ACTIVITY: Practice Getting Help

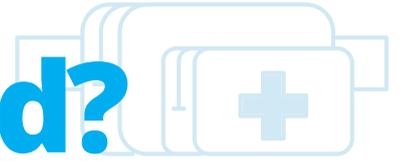
With a partner, act out a water emergency in front of your class. One person plays the role of the victim; the other person plays the role of the witness.

**Victim:** Act out all the steps you should take if you fall into swift-moving water. Be sure to include calling out for help.

**Witness:** Act out how you would help the victim. Be sure to include calling 911 and answering the five questions listed above.

**IMPORTANT: Do NOT get into water to act this out!**

# is your family prepared?



Floods and freak storms are rare, but a little preparation will go a long way if one occurs in your area. Whether you live near a reservoir or river or very far away from one, **share these flood safety tips with your family.**

## Make an emergency kit

Work with your family to gather blankets, flashlights, and enough food, water and supplies for three days per person and for any pets. Put everything into easy-to-grab backpacks or a large plastic box. Include a radio, extra batteries, first aid supplies, cash, medicines, toilet paper, a cell phone car charger, and one complete change of clothing and shoes per person, including wet-weather gear.



## Make a family flood evacuation plan

If your home is at risk of flooding, you will need to evacuate immediately to a safer place at a higher elevation. Work with your family to decide on a meeting place. **Discuss the questions below and post your answers where everyone can see them:**

- **Where is our family meeting place?**
- **How will we get there? (Be sure your routes avoid commonly flooded roadways.)**
- **Where is our emergency kit? Who will be responsible for taking it?**
- **How will we help anyone in our family who is elderly or needs special assistance?**
- **How will we transport our pets?**

Test your plan and adjust it to make sure it works for everyone in your family. Then use your plan to practice regular flood evacuation drills with your family, just as you practice fire drills at school.



### **ACTIVITY:** Create an Emergency Contact List

During some disasters, long-distance calls may be easier to make than local calls. Make a list ahead of time of at least three people who live outside your state who can help your family and friends stay in touch during a flood or other natural disaster.

- Include their name, state, area code, and phone number.
- Make sure everyone in your family has this list in their cell phones and a printed copy in their backpack or wallet.

# flood safety tips

If your neighborhood is at risk of flooding, use a battery-powered radio to listen for updates from local public safety officials and/or the National Weather Service Emergency Alert System.

If you are warned to evacuate, grab your emergency kit and contact list and use your family evacuation plan to get to your safe meeting place on higher ground. **Take these precautions to avoid electrical hazards:**

- **Water conducts electricity**, so do not touch electrical devices or appliances if you are wet or standing in water. Stay out of flooded basements.
- **Leave early to avoid being trapped.** Ask an adult to shut off electricity at the main breaker before you go.

## Watch out for downed power lines!

Storms that cause flooding may also knock down electric power lines. Fallen power lines may be obvious and easy to see, or may be hidden in puddles or fallen branches. That's why it's so important to stay indoors during storms, and to look out for power lines if you are outdoors after a storm is over.

If you see a fallen power line, **immediately report it to 911** and **your local electric utility**. Stay at least 50 feet away from the line and anything touching it.

**If a line comes down on or near your vehicle, call 911** and stay inside until utility workers tell you to exit. Warn bystanders to stay far away. Anyone who touches the vehicle and the ground at the same time could be shocked or even killed!



## ACTIVITY: MAP YOUR WATERWAYS

Use a map to identify the waterways closest to your home. Do they supply drinking water? Irrigation water? Are they used for recreation? Are they part of a local hydropower system?

**BONUS:** Have these waterways ever flooded, and if so, how badly? Contact your local water agency or do some Internet research to find out.



# everyone lives in a watershed

No matter where you live—in an urban area, a suburban neighborhood, or rural countryside—you live in a **watershed**. A watershed is the land area that drains storm water runoff into a body of water. Runoff is precipitation that is not absorbed by soil.

## Where runoff goes

All watersheds get their water from storms; however, watersheds act differently depending on their location.

- **In towns and cities**, rain or snowmelt flows as runoff over pavement and other impervious (nonabsorbent) surfaces. It then runs into storm drains, and eventually to rivers and wetlands.



- **In the countryside**, where there are no storm drains, most water enters lakes and rivers directly as runoff from the surrounding landscape.

### ACTIVITY: Word Game

Unscramble these words and then use them to complete the paragraph.

reath

apvemnte

offunnr

wtershdea

oaks

Excess \_\_\_\_\_ can cause problems in a \_\_\_\_\_ such as flooding and erosion (the wearing down or washing away of the \_\_\_\_\_). Flooding happens when the ground can no longer \_\_\_\_\_ up all the water passing over it, or when there is too much \_\_\_\_\_ and not enough ground to absorb it.

# create your own watershed



See for yourself how a watershed works by building a model watershed with clay and rocks.

## Materials:

- Baking pan, at least 9" x 13"
- Plastic wrap
- Modeling clay
- Rolling pin for clay
- Variety of small rocks
- Several sheets of newspaper
- Several sheets of aluminum foil
- A measuring cup full of water
- Blue food coloring
- Ground black pepper
- Thick black marker
- **Set Up:** Make a landscape in your baking pan. Use rocks, foil, and newspaper to form mountains, hills, and valleys. Roll out several thin layers of clay and spread them over your landscape and part way up the inside edges of the baking pan. Now make rivers and lakes by pressing down into the clay.
- **Predict:** Where will water flow if you pour it onto the highest point of your landscape? Cover your landscape with a sheet of plastic wrap. Use a marker to show the route that you predict the water will take, and where it will collect in pools. Take the plastic off and set it aside.
- **Investigate:** Put several drops of food coloring into the water in your measuring cup. Pour at least 1/2 cup of water onto your landscape at its highest point. Observe the path it takes and where it collects in pools, and compare this to the prediction you made. Now put a pinch of "pollution" (black pepper) onto a few dry spots in your landscape. Pour another 1/2 cup of water onto the model from its highest point. Observe what happens to the pollution.

## ACTIVITY: GOING FURTHER

In what direction did the water flow? Did it take the route you predicted? What happened to the pollution? What would it take for you to remove the pollution from your landscape now? How is your landscape like a real-life watershed? How is it different?





# runoff and the environment

As it flows along, runoff collects everything in its path. This includes litter, fertilizer and pesticides, spilled gas and oil, eroded soil, and soapy water from washing cars. These are examples of **pollutants**, substances that make the water dirty or toxic to life forms.

## Polluted runoff is the single biggest threat to the health of our waterways:

- **Fertilizer carried into waterways contributes to "dead zones,"** places where no plants, fish, or animals can live. The nitrogen in the fertilizer causes an overgrowth of algae, which consumes the oxygen in the water and blocks the sunlight needed by plants and animals. There is a dead zone in the Gulf of Mexico that is nearly the size of the state of New Jersey!
- **Motor oil is another common pollutant carried by runoff.** Just one quart of oil can make 250,000 gallons of water toxic to wildlife! (That's as much water as it takes to cover an acre of land almost 1 foot deep.)



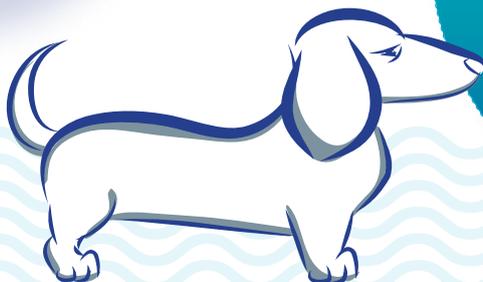
### ACTIVITY: CLEAN UP YOUR WATERSHED!

Find out if there are any river, beach, or highway cleanup projects in your area and see if you can participate, either with your family or your class.



### Pet Peeve

A day's worth of solid waste from a large dog contains about 7.8 billion bacteria. Bacteria carried by runoff can make animals and people sick. So keep your dog's waste out of your local watershed by collecting it in a plastic bag and disposing of it properly.



# protect your local waterways



Try this three-week class project to help keep trash out of local waterways.

**Step 1: Take a storm water walk.** With a partner, walk around your school grounds and observe the storm water system. On a separate sheet of paper, answer these questions:

- **When it rains, where does the runoff from your school flow? Does it enter a nearby storm drain, river, lake, and/or canal?**
- **Look for trash that could flow into storm drains or nearby waterways. Where is this trash located?**

**Step 2: Select an area to monitor.** As a class, discuss what you found and agree upon the area you will monitor. It should be an area with trash that could be carried into local waterways by storm water runoff. If you do not have trash at your school, your teacher can help you identify another area to monitor in your community.

**Step 3: Count the trash.** Every day for one week, at the same time of day, a group of students will go to the area to count all the pieces of trash there, pick them up, and put them into garbage cans or recycling bins as appropriate. (Be sure to wear gloves.) Record the daily trash count on the first row in the chart below. At the end of the week, calculate the average.

**Step 4: Teach others.** Work as a class to make posters about the importance of putting trash into garbage cans and recycling bins so that it does not end up in local waterways. Hang your posters where other students will see them daily.

**Step 5: Count the trash again.** After your posters have been up for one week, repeat Step 3. Record the daily totals and the average on the second row below.

**Step 6: Evaluate your results.** Did the amount of trash go down after your poster campaign? If so, congratulations! If not, discuss as a class some factors that might explain your findings, and brainstorm other ways to reduce water pollution from your school.

## ACTIVITY: Daily Trash Count

	Mon.	Tues.	Wed.	Thurs.	Fri.	Average
Week 1:						
Week 3:						



# GET WATER WISE

Fill in the blanks of the sentences by choosing from among the words you see in the water droplet. Look on the pages listed for clues.

1. Most of the fresh water on earth is frozen in \_\_\_\_\_. (p. 2)
2. The gas form of water is also known as \_\_\_\_\_. (p.3)
3. In the hydrologic cycle, after water reaches rivers, wetlands, and oceans, it \_\_\_\_\_ back into the air. (p.3)
4. \_\_\_\_\_ uses the mechanical energy of falling water to generate electricity. (p.4)
5. Use the buddy system; never \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, or \_\_\_\_\_ alone. (p.6)
6. Never play on, near, or in a hydropower \_\_\_\_\_ or \_\_\_\_\_. (p. 7)
7. If you see a fallen \_\_\_\_\_, stay far away and immediately report it to 911 and your local electric utility. (p. 11)
8. The land around where you live that drains storm water into a body of water is a \_\_\_\_\_. (p.12)
9. Storm water runoff can collect and carry along \_\_\_\_\_. (p. 14)
10. Cleaning up pet waste is one way to \_\_\_\_\_ water. (p.14)

