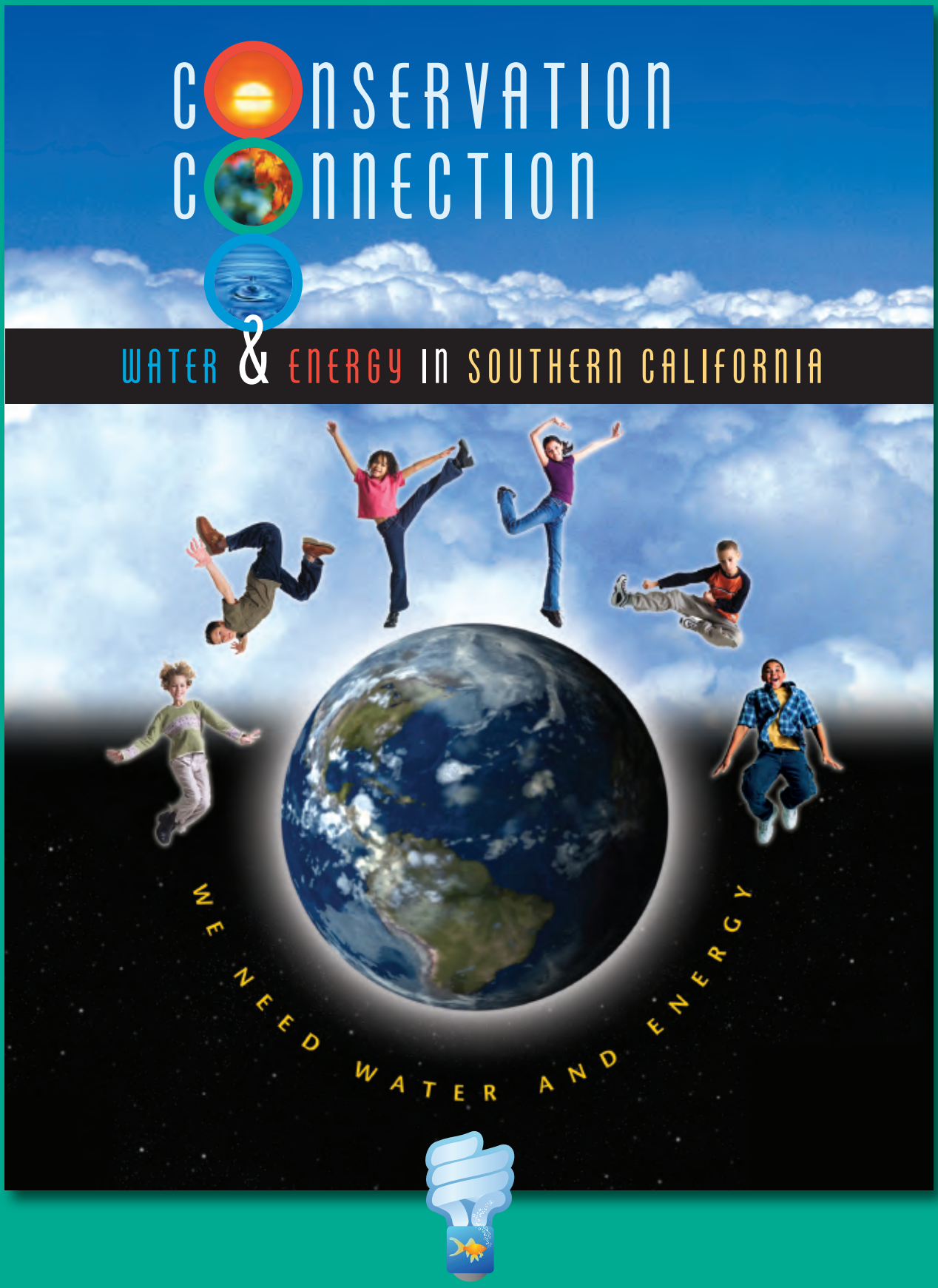
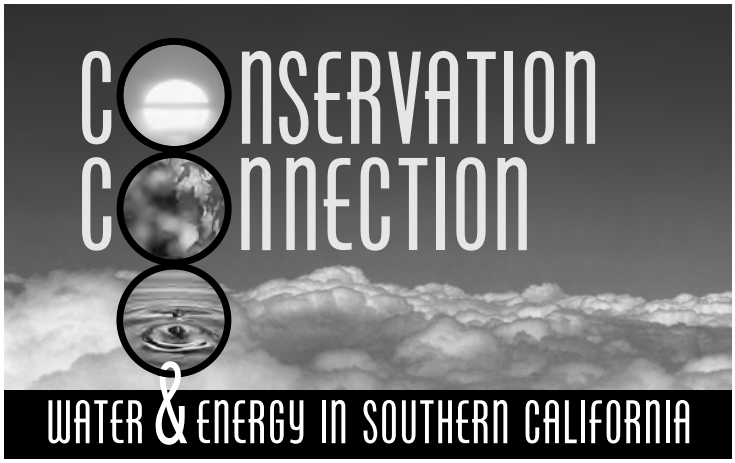
CONSERVATION CONNECTION

WATER & ENERGY IN SOUTHERN CALIFORNIA



TEACHER GUIDE



A CURRICULUM SUPPLEMENT ANALYZING WATER & ENERGY USE AT HOME AND AT SCHOOL

PRODUCED BY:

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Adapted from
Conservation Connection: Water & Energy Use in California
which was developed in 2004 by
Central Basin Municipal Water District and West Basin Municipal Water District
through a grant from The State of California Department of Water Resources

CURRICULUM DEVELOPMENT: Educational Development Specialists

GRAPHIC DESIGN: Design Perspective **WEB APPLICATION:** Macdonald Design

If you have any questions about *Conservation Connection: Water and Energy in Southern California* or would like further information about Metropolitan's education programs, please call (213) 217-8448 or e-mail MWDEducationPrograms@mwdh2o.com.

TEACHER GUIDE

Metropolitan Water District of Southern California is pleased to present *Conservation Connection*, a curriculum supplement that "connects" middle-school students to their use of water and energy and the need to conserve these resources, especially in southern California.

The program focuses on Water & Energy Surveys—for both home and school. With these surveys, students have the opportunity to:

- audit water and energy use at their homes and their school
- input their findings online
- receive and review recommendations to improve
- make and implement plans to conserve water and energy

By participating in this action-based program, students will learn where we get the water and energy that we use, how we use these resources, and why we need to conserve them. Students will look critically at important environmental issues and take responsibility for finding solutions so that we have enough water and energy for the future.

Learning Objectives

1. Identify basic facts about the sources supplying water in the entire state and in southern California—surface water and groundwater.

2. Identify the various uses of water throughout California in the agricultural, environmental, and urban sectors, and identify how the percentages differ by sector between the entire state and southern California.

3. Identify the problems of water supply meeting water demand, including:
   - cost
   - the environment
   - population

4. Identify ways of stretching our water supply, including:
   - recycling
   - desalination
   - new water-efficient technologies
   - conservation practices

5. Identify basic facts about the primary sources supplying energy in California, including:
   - fossil fuels
   - hydropower
   - nuclear power
   - biomass
   - geothermal
   - wind
   - solar

6. Identify the various uses of energy throughout California in the transportation, industry, business, and residential sectors.

7. Identify the problems of energy supply meeting energy demand, including:
   - supply
   - the environment
   - cost
   - population

8. Identify ways of supplying energy in the future, including:
   - new energy-efficient technologies
   - renewable sources
   - fuel cells
   - conservation practices

9. Assess water and energy usage by surveying:
   - personal habits
   - home use and efficiency
   - school use and efficiency

10. Identify, plan, and implement measures to save water and energy at home and at school.

Lesson Format

Each lesson is formatted as follows:

Lesson Overview: Briefly summarizes the activities that students will be doing.

Vocabulary: Lists words shown in italics in the student booklet that are important and that may be unfamiliar to students.

Materials and Preparation: Specifies the materials needed in the lesson (e.g., wall map, demonstration equipment) and describes what needs to be done prior to teaching the lesson (e.g., print online survey, set up demonstration).

Approximate Time Requirement: Gives the estimated amount of time needed to conduct all of the activities within the lesson.

Procedures: Provides detailed steps for conducting the activities, including discussion questions and suggested answers.

Extensions: Suggests other activities to extend the learning, including conducting experiments, providing more practice, addressing other content standards, and expanding the concepts into the community. **NOTE:** You may want to begin a lesson with one of these activities, incorporate them into the lesson, or use them as follow-up.

Materials

The following materials are included to teach the lessons:

- Teacher Guide
- Student Booklet (28 pages)
- Online Water & Energy Surveys
  - For Home
  - For School
- Online Interactive Conservation House

Any other materials needed to conduct demonstrations or other activities are common items, such as poster paper, water, gallon containers. All necessary materials and preparation are listed at the beginning of each lesson.

Instructional Strategies

At the beginning of each section in the student booklet, students are asked to **Think About It....** Use these questions to challenge students to explore the topic before reading the information in **Learn About It....** Discussion questions are provided for each **Learn About It...** section. You can use these questions after students have read the text, or alternatively, write the questions on the chalkboard, divide students into groups, and have each group answer the questions as they read.

This banner in the student booklet flags a related **website** that will provide more information on the topic.

This **"connection"** symbol in the student booklet will help students connect to the information and actively involve them in learning.

The ***Home Water & Energy Survey***, which is online at **surveys.bewaterwise.com**, is assigned in Lesson 1, giving students time with their families to complete it and time to input their answers by Lesson 8 when the surveys are analyzed. This time also allows students to get personally involved in their use of water and energy while they are learning about the topic.

The ***School Water & Energy Survey*** is presented in Lesson 9, but it also can be conducted while students are learning about water and energy in California. The ***School Survey*** or a community survey could also be used as a culminating activity.

Correlations

The activities within these lessons can be used to support many of the California State Content Standards and the Key Education and the Environment Initiative Principles and Concepts. A chart in the appendix shows lesson correlations with standards in Science, Language Arts, and Math for grades 6 through 8 and with EEI Principles and Concepts.

Assessment

A **cognitive assessment** of the objectives listed previously is included in the Appendix. If students read, discuss, and practice the information contained in the student booklet, the test can be used to assess their comprehension.

Portfolios containing students' worksheets, surveys, and conservation plans can also be used to assess students, especially in relation to implementing and monitoring their plans. Portfolios can become an integral aspect of the instructional process. If less focus is placed on the cognitive information and more on the applied learning, the portfolio assessment would be most appropriate.

CONTENTS

CONTENTS *(Continued)*

LESSON 1: WATER, ENERGY, & YOU

Lesson Overview

Students will:

- be introduced to the importance of water and energy
- compare their use of water and energy to use in the past
- keep track of personal water and energy use
- begin the *Home Water & Energy Survey*

Vocabulary

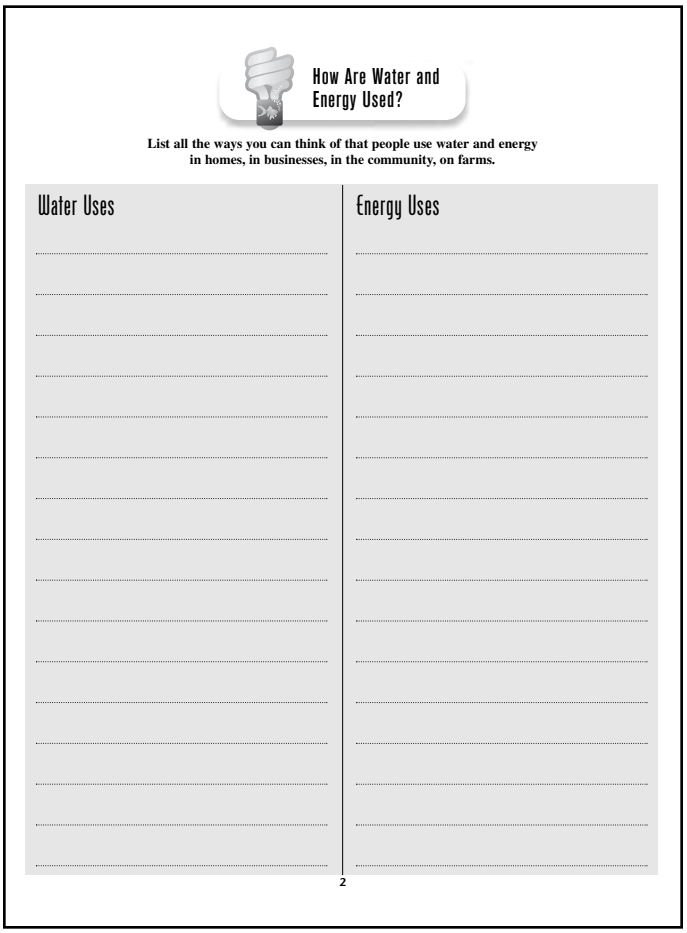
- condensation
- evaporation
- nonrenewable
- precipitation
- renewable
- transpiration

Materials and Preparation

- *Conservation Connection* student booklets
- *Home Water & Energy Survey*
  - a copy for each student printed out from **surveys.bewaterwise.com** or from the Appendix

Approximate Time Requirement

- 1 class period



How Are Water and Energy Used?

List all the ways you can think of that people use water and energy in homes, in businesses, in the community, on farms.

Water Uses	Energy Uses

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Procedures

I. Introduce the program

A. Distribute a copy of the **student booklet,** *Conservation Connection*, to each student and explain that the class is going to be learning about water and energy in California, especially in southern California. Allow students a few moments to look through the book.

B. Divide students into groups and have them turn to page 2 in their booklets—*How Are Water and Energy Used?* Read aloud the directions at the top of the page. Ask students to work with group members to list all the uses they can think of for water and for energy. Remind students that water and energy are used in places other than in the home, for example to fight fires, grow food, manufacture paper.

C. When students have completed their lists, ask each group to read what they've listed.

D. Point out that along with their direct uses, they are responsible for many "indirect" uses of water and energy in industry and agriculture.

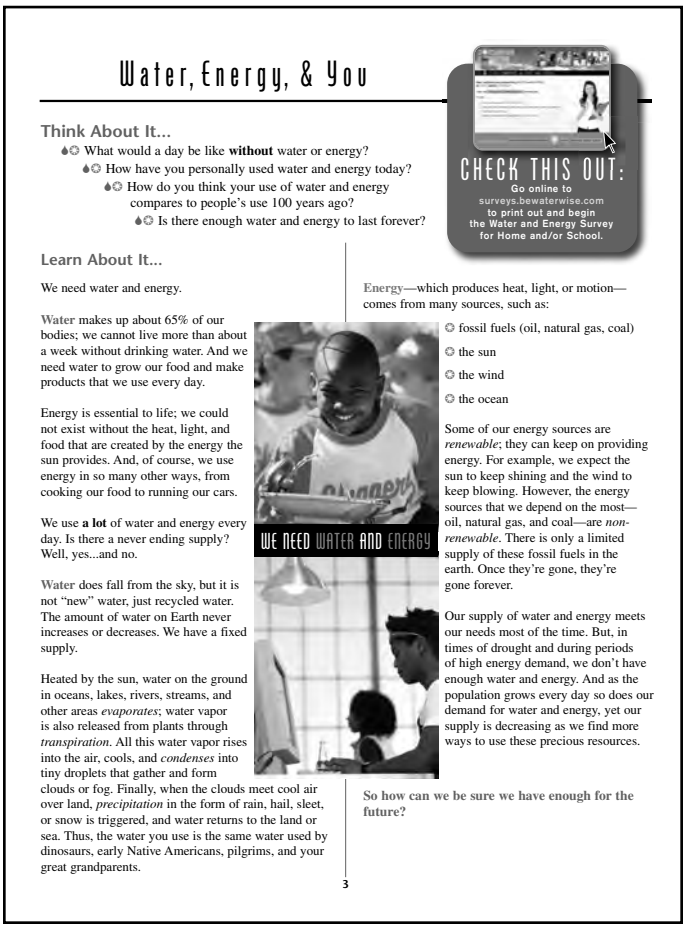
II. Think About Water, Energy, & You

A. Ask students to turn to page 3—*Water, Energy, & You.* Read aloud and have students discuss the questions under **Think About It....** In the discussion of each question, allow students to share their ideas, but be sure to point out the following:

1. **What would a day be like without water or energy?**
   There would be no day as we know it without water and energy; we need the radiant heat and light from the sun; we need water to drink. Without water and energy, we could not live.
2. **How have you personally used water and energy today?**
   Some personal uses may not be so obvious, such as reading clocks, drinking milk that was kept cold in the refrigerator, talking on the phone, and flushing toilets.

3. **How do you think your use of water and energy compares to people's use 100 years ago?**
   A hundred years ago, people did not have such easy access to water and energy, and they did not have so many products that use water and energy. Edison did not invent the light bulb until 1879, and the first electric power station wasn't built until 1882; the electric vacuum cleaner and washing machine were invented in 1907; the Model T automobile was put into production in 1913; only about 60% of farms had flowing indoor water by 1936.

4. **Is there enough water and energy to last forever?**
   We do expect the sun to continue to shine and rain to continue to fall; thus, we expect there to always be water and energy. However, will we always have enough clean water and energy when and where it is needed for everyone?



Water, Energy, & You

Think About It...

- What would a day be like **without** water or energy?
- How have you personally used water and energy today?
- How do you think your use of water and energy compares to people's use 100 years ago?
- Is there enough water and energy to last forever?

CHECK THIS OUT:
Go online to surveys.bewaterwise.com to print out and begin the Water and Energy Survey for Home and/or School.

Learn About It...

We need water and energy.

Water makes up about 65% of our bodies; we cannot live more than about a week without drinking water. And we need water to grow our food and make products that we use every day.

Energy is essential to life; we could not exist without the heat, light, and food that are created by the energy the sun provides. And, of course, we use energy in so many other ways, from cooking our food to running our cars.

We use **a lot** of water and energy every day. Is there a never ending supply? Well, yes...and no.

Water does fall from the sky, but it is not "new" water, just recycled water. The amount of water on Earth never increases or decreases. We have a fixed supply.

Heated by the sun, water on the ground in oceans, lakes, rivers, streams, and other areas *evaporates*; water vapor is also released from plants through *transpiration*. All this water vapor rises into the air, cools, and *condenses* into tiny droplets that gather and form clouds or fog. Finally, when the clouds meet cool air over land, *precipitation* in the form of rain, hail, sleet, or snow is triggered, and water returns to the land or sea. Thus, the water you use is the same water used by dinosaurs, early Native Americans, pilgrims, and your great grandparents.

Energy—which produces heat, light, or motion—comes from many sources, such as:

- fossil fuels (oil, natural gas, coal)
- the sun
- the wind
- the ocean

Some of our energy sources are *renewable*; they can keep on providing energy. For example, we expect the sun to keep shining and the wind to keep blowing. However, the energy sources that we depend on the most—oil, natural gas, and coal—are *nonrenewable*. There is only a limited supply of these fossil fuels in the earth. Once they're gone, they're gone forever.

Our supply of water and energy meets our needs most of the time. But, in times of drought and during periods of high energy demand, we don't have enough water and energy. And as the population grows every day so does our demand for water and energy, yet our supply is decreasing as we find more ways to use these precious resources.

So how can we be sure we have enough for the future?

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III. Learn About Water, Energy, & You

A. Have students read the text under **Learn About It...** on page 3. Then use the questions below to briefly discuss what they read. **Alternatively,** write the questions on the chalkboard, divide students into groups, and have each group answer the questions using the information on page 3 in their booklets

1. **What is the water cycle?**
   Water circulates constantly. Water that evaporates from the ground or that is released from plants through transpiration rises into the air as water vapor. In the air, it cools and condenses and eventually falls to the earth as precipitation (rain, snow, sleet, hail), where it again evaporates and rises into the air.

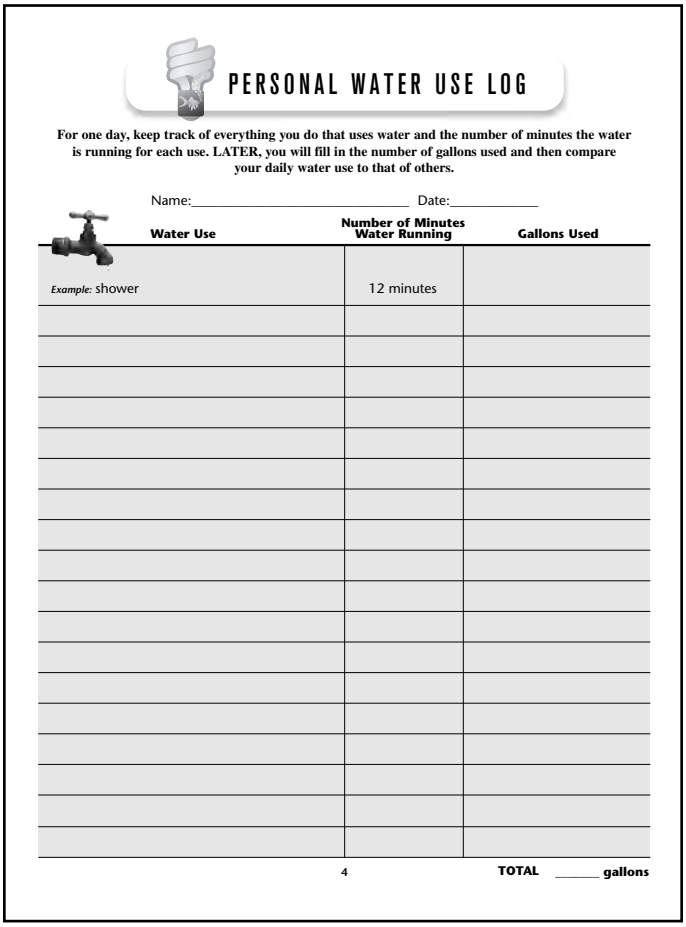
2. **Can we increase our supply of water?**
   No. We have a fixed supply of water. Varying amounts of water are available in different places and at different times depending on geography and weather, but only a limited amount of water exists on Earth.

3. **How can you tell when energy is being used?**
   Energy is being used any time there is heat, light, or motion.

4. **What's the difference between *renewable* and *nonrenewable* energy sources?**
   Renewable energy sources never get used up; they are constantly resupplied by natural processes. For example, sun, wind, wood, and water are all renewable energy sources. Nonrenewable sources have only a limited amount. For example, once we've used up all the fossil fuels (oil, natural gas, coal), there will never be any more.

5. **Why do we need to be concerned about our supply of water and energy?**
   As our population grows and as we find more and more ways to use energy and water, we are using more water and energy all the time. In times of drought, our supply of water is sometimes not enough for everyone. And during periods of high energy demand, such as on hot summer days, we sometimes can't produce enough energy.

6. **So how can we be sure we have enough water and energy for the future?**
   Allow students to share their ideas.



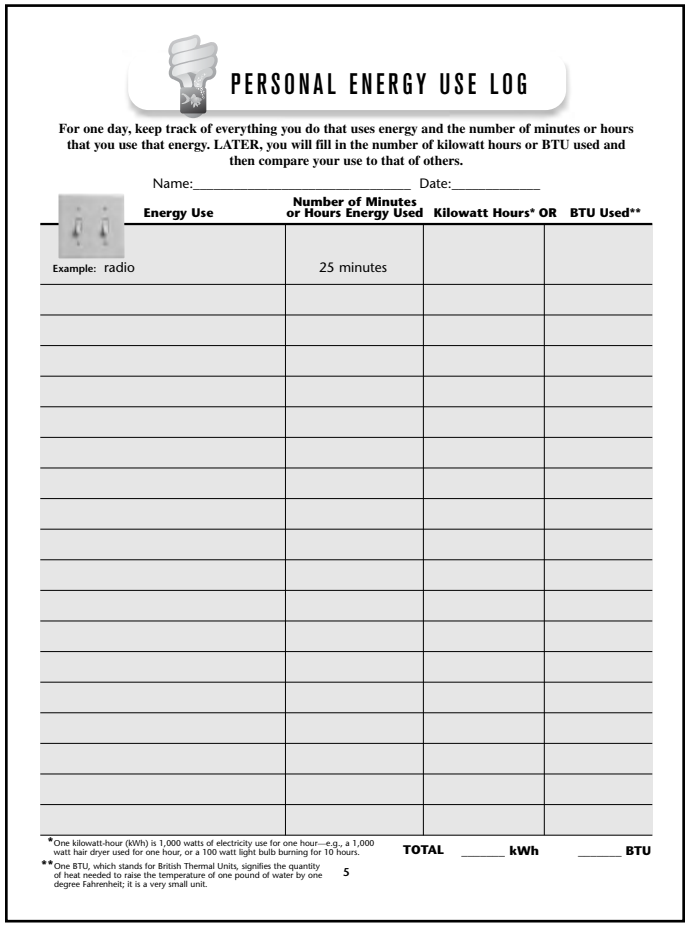
PERSONAL WATER USE LOG

For one day, keep track of everything you do that uses water and the number of minutes the water is running for each use. LATER, you will fill in the number of gallons used and then compare your daily water use to that of others.

Name:_____ Date:_____

Water Use	Number of Minutes Water Running	Gallons Used
Example: shower	12 minutes	

4 **TOTAL** _____ **gallons**



PERSONAL ENERGY USE LOG

For one day, keep track of everything you do that uses energy and the number of minutes or hours that you use that energy. LATER, you will fill in the number of kilowatt hours or BTU used and then compare your use to that of others.

Name:_____ Date:_____

Energy Use	Number of Minutes or Hours Energy Used	Kilowatt Hours* OR	BTU Used**
Example: radio	25 minutes		

*One kilowatt-hour (kWh) is 1,000 watts of electricity use for one hour—e.g., a 1,000 watt hair dryer used for one hour, or a 100 watt light bulb burning for 10 hours.

**One BTU, which stands for British Thermal Units, signifies the quantity of heat needed to raise the temperature of one pound of water by one degree Fahrenheit; it is a very small unit.

TOTAL _____ **kWh** _____ **BTU**

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IV. Track Personal Water and Energy Use

A. Have students turn to pages 4 and 5 in their booklets—*Personal Water Use Log* and *Personal Energy Use Log*. Explain that for 24 hours (starting either now or tomorrow morning), they are to keep track of every time they personally use water and energy. Review the examples.

B. Point out that on each page they are to fill in only the first two columns at this point, indicating what they used and for how long they used it. Explain that the last columns—"Gallons Used" (for water) and "Kilowatt Hours or BTU Used" (for energy)—will be completed later (in Lessons 3 and 6).

V. Introduce the Home Water & Energy Survey

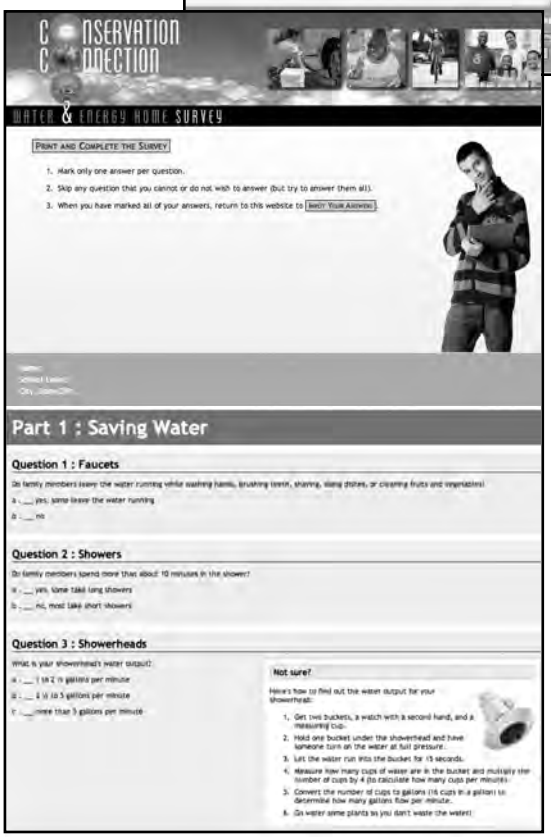
A. Ask students if they think any water or energy is wasted in their homes.

B. Distribute a ***Home Water & Energy Survey*** to each student, printed out from the website (**surveys.bewaterwise.com)** or from the Appendix. **Alternatively,** show students a copy of the survey and instruct them how to go online to print out their own copies.

C. Read aloud and discuss the directions for completing the survey. Emphasize that students should work with their families to answer the questions. Explain that some of the items are easy to answer, but some will take investigation. Tell students that some questions—especially those that show the help symbol at right—may require the assistance of an adult. Point out that next to some items is a box containing tips to help answer the question.

D. Tell students that after their surveys are completed they will input their answers on the website and receive recommendations as to how their families can better conserve water and energy.

E. Set a date for the surveys to be completed and for students' answers to be input online. ***(Note**: Students' results will be analyzed in Lesson 8.)*



♦✪ Extension Activities

- **Prepare water and energy timelines.** Research significant dates in our history of water *(e.g., in 1888 Thomas Crapper perfected the valve system of the toilet; in 1913 the Los Angeles Aqueduct began delivering water; in 1914 the first drinking water standards were adopted)* and energy *(e.g., in 1879 Thomas Edison invented the light bulb; in 1903 the Wright Brothers flew the first airplane; in 1942 the first nuclear chain reaction was demonstrated)* and make murals depicting the events throughout history.
- **Compare water and energy use throughout history**. Divide students into groups and assign each group to research a particular historical group of people—such as the first colonists, early Native Americans, settlers on the frontier, plantation owners during the Civil War, etc.—to determine their water and energy sources and uses.

LESSON 2: WATER SOURCES & WATER DISTRIBUTION

Lesson Overview

Students will:

- learn about surface water and groundwater
- learn how water is distributed—especially in southern California

Vocabulary

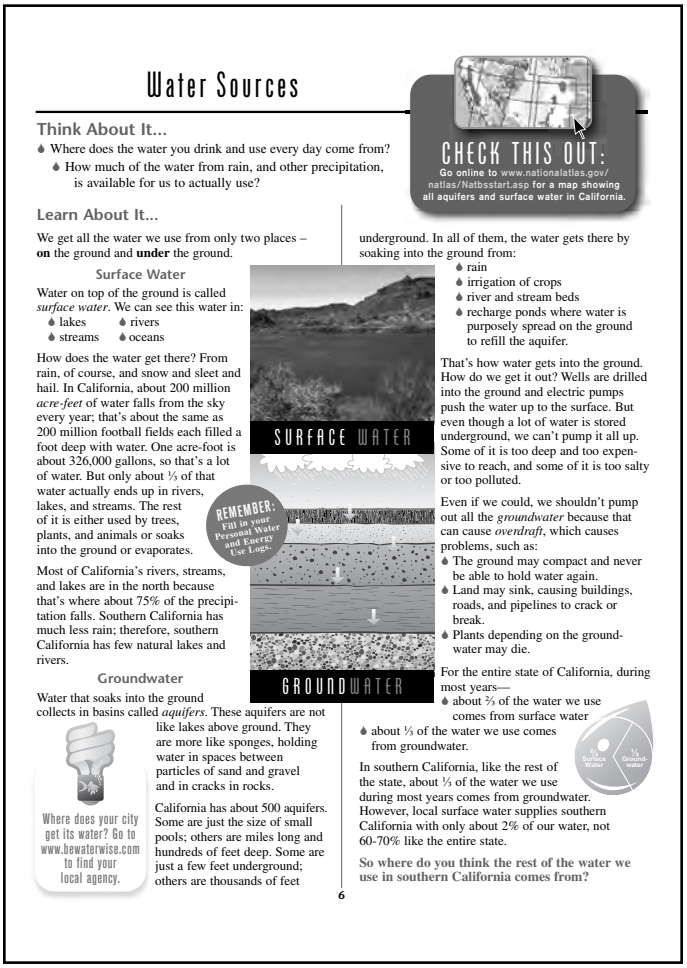
- acre-foot
- aqueduct
- aquifer
- groundwater
- overdraft
- reservoir
- surface water

Materials and Preparation

- *Conservation Connection* student booklets
- Topographical wall map of California
- Materials for demonstration (optional)
  - large glass jar or small aquarium
  - aquarium gravel
  - watering can
  - meat baster
  - water

Approximate Time Requirement

- 1 class period



Water Sources

Think About It...

- Where does the water you drink and use every day come from?
- How much of the water from rain, and other precipitation, is available for us to actually use?

CHECK THIS OUT:
Go online to www.nationalatlas.gov/natlas/Natbsstart.asp for a map showing all aquifers and surface water in California.

Learn About It...

We get all the water we use from only two places – **on** the ground and **under** the ground.

Surface Water

Water on top of the ground is called *surface water*. We can see this water in:

- lakes
- rivers
- streams
- oceans

How does the water get there? From rain, of course, and snow and sleet and hail. In California, about 200 million *acre-feet* of water falls from the sky every year; that's about the same as 200 million football fields each filled a foot deep with water. One acre-foot is about 326,000 gallons, so that's a lot of water. But only about ⅓ of that water actually ends up in rivers, lakes, and streams. The rest of it is either used by trees, plants, and animals or soaks into the ground or evaporates.

REMEMBER: Fill in your Personal Water and Energy Use Logs.

Most of California's rivers, streams, and lakes are in the north because that's where about 75% of the precipitation falls. Southern California has much less rain; therefore, southern California has few natural lakes and rivers.

Groundwater

Water that soaks into the ground collects in basins called *aquifers*. These aquifers are not like lakes above ground. They are more like sponges, holding water in spaces between particles of sand and gravel and in cracks in rocks.

Where does your city get its water? Go to www.bewaterwise.com to find your local agency.

California has about 500 aquifers. Some are just the size of small pools; others are miles long and hundreds of feet deep. Some are just a few feet underground; others are thousands of feet underground. In all of them, the water gets there by soaking into the ground from:

- rain
- irrigation of crops
- river and stream beds
- recharge ponds where water is purposely spread on the ground to refill the aquifer.

SURFACE WATER

GROUNDWATER

That's how water gets into the ground. How do we get it out? Wells are drilled into the ground and electric pumps push the water up to the surface. But even though a lot of water is stored underground, we can't pump it all up. Some of it is too deep and too expensive to reach, and some of it is too salty or too polluted.

Even if we could, we shouldn't pump out all the *groundwater* because that can cause *overdraft*, which causes problems, such as:

- The ground may compact and never be able to hold water again.
- Land may sink, causing buildings, roads, and pipelines to crack or break.
- Plants depending on the groundwater may die.

For the entire state of California, during most years—

- about ⅔ of the water we use comes from surface water
- about ⅓ of the water we use comes from groundwater.

In southern California, like the rest of the state, about ⅓ of the water we use during most years comes from groundwater. However, local surface water supplies southern California with only about 2% of our water, not 60-70% like the entire state.

So where do you think the rest of the water we use in southern California comes from?

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Procedures

I. Think About Water Sources

A. Have students open their student booklets to page 6, *Water Sources.*

B. Read aloud and discuss the questions under **Think About It....**

II. Learn About Water Sources

A. Display a topographical map of California. Have students note where most of the natural rivers and lakes are and where most of the cities are. Ask students why they think that is.

B. Have students read the information on page 6 about surface water and groundwater and use the following questions to generate a discussion.

1. **What happens to all the rain that falls?**
   About 1/3 of the rain that falls ends up in rivers, lakes, and streams. The rest is used by plants and animals, soaks into the ground, and evaporates.
2. **What is surface water?**
   Surface water is all the water we see on the surface of the Earth—water in creeks, streams, rivers, lakes, the ocean.
3. **What is groundwater?**
   Groundwater is water under the surface of the Earth that collects in aquifers, which are basins underground where water is stored in spaces between particles of sand, gravel, and rock.
4. **How does water get into the ground?**
   Water soaks into the ground from rain, irrigation, river beds, and recharge ponds.
5. **How do we get the water out of the ground?**
   Wells are drilled into the ground and the water is pumped up.
6. **What does "overdraft" mean?**
   "Overdraft" means that too much water has been pumped out of the ground, which can cause land to sink, the aquifer to compact and be unusable, or plants depending on the groundwater to die.

7. **Why are most of California's rivers, streams, and lakes in northern California?**
   About 75% of the precipitation in California falls in the north, creating rivers, streams, and lakes.

8. **In California, how much of the water we use comes from surface water and how much from groundwater?**
   Most years, about 2/3 of the water we use comes from surface water and about 1/3 comes from groundwater.

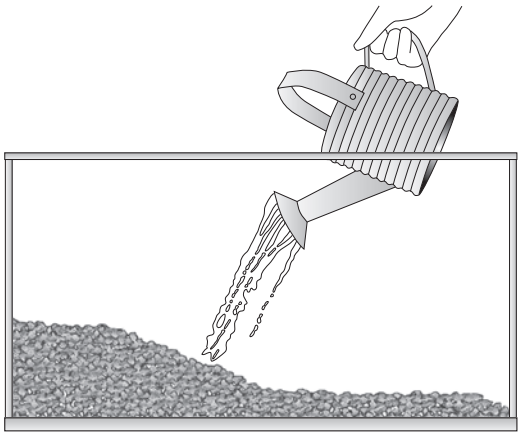
9. **In southern California, do we use the same amounts of surface water and groundwater as in the entire state?**
   No. Groundwater use in southern California is the same—about 1/3 or 33% of our total supply. But local surface water provides only about 2% of our supply.

10. **So where does the rest of the water we use in southern California come from?**
    Allow students to share their ideas.

III. (optional) Demonstrate Groundwater and Surface Water

A. Fill a jar or aquarium with gravel, building the ground up slightly higher on one side than the other. Sprinkle water from a watering can into the jar or aquarium to simulate rain. Saturate the ground but do not pour so much that water shows above ground. To simulate the drilling of a well, use the meat baster to pump up some groundwater.

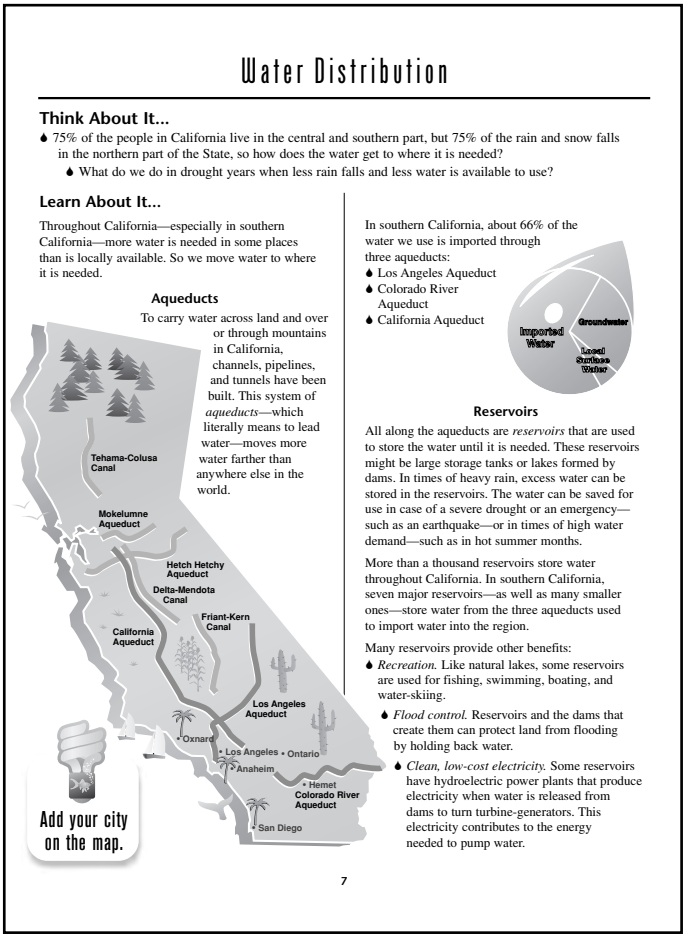
B. Sprinkle more water until a "lake" forms at the low ground end. Have students experiment with "raining" more and "pumping" more to demonstrate the interaction between groundwater and surface water.



IV. Think About Water Distribution

A. Have students turn to page 7 in their student booklets—*Water Distribution.*

B. Read aloud and discuss the **Think About It....** questions.



Water Distribution

Think About It...

- 75% of the people in California live in the central and southern part, but 75% of the rain and snow falls in the northern part of the State, so how does the water get to where it is needed?
- What do we do in drought years when less rain falls and less water is available to use?

Learn About It...

Throughout California—especially in southern California—more water is needed in some places than is locally available. So we move water to where it is needed.

Aqueducts

To carry water across land and over or through mountains in California, channels, pipelines, and tunnels have been built. This system of *aqueducts*—which literally means to lead water—moves more water farther than anywhere else in the world.

Tehama-Colusa Canal
Mokelumne Aqueduct
Hetch Hetchy Aqueduct
Delta-Mendota Canal
Friant-Kern Canal
California Aqueduct
Los Angeles Aqueduct
Oxnard
Los Angeles
Ontario
Anaheim
Hemet
Colorado River Aqueduct
San Diego
Add your city on the map.

In southern California, about 66% of the water we use is imported through three aqueducts:

- Los Angeles Aqueduct
- Colorado River Aqueduct
- California Aqueduct

Imported Water
Groundwater
Local Surface Water

Reservoirs

All along the aqueducts are *reservoirs* that are used to store the water until it is needed. These reservoirs might be large storage tanks or lakes formed by dams. In times of heavy rain, excess water can be stored in the reservoirs. The water can be saved for use in case of a severe drought or an emergency—such as an earthquake—or in times of high water demand—such as in hot summer months.

More than a thousand reservoirs store water throughout California. In southern California, seven major reservoirs—as well as many smaller ones—store water from the three aqueducts used to import water into the region.

Many reservoirs provide other benefits:

- *Recreation.* Like natural lakes, some reservoirs are used for fishing, swimming, boating, and water-skiing.
- *Flood control.* Reservoirs and the dams that create them can protect land from flooding by holding back water.
- *Clean, low-cost electricity.* Some reservoirs have hydroelectric power plants that produce electricity when water is released from dams to turn turbine-generators. This electricity contributes to the energy needed to pump water.

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V. Learn About Water Distribution

A. Have students read the information on page 7 and use the following questions to generate a discussion.

1. **What are aqueducts?**
   Aqueducts are channels, pipelines, and tunnels through which water travels across land.

2. **What are the three aqueducts bringing water into southern California?**
   The Los Angeles Aqueduct, the Colorado River Aqueduct, and the California Aqueduct bring water into southern California.

3. **How much of the water we use in southern California comes through these three aqueducts?**
   About 66% of our water is imported through these three aqueducts.
4. **Where do we store the water until it is needed?**
   We store water in reservoirs—which are either lakes or large tanks.
5. **What other uses do reservoirs have?**
   Reservoirs can provide recreation, flood control, and electricity if they have hydroelectric power plants.
6. **Why do you think some reservoirs prohibit activities like swimming and water skiing?**
   Limiting the amount of actual "body contact" in the water lowers the level of contamination, making water treatment less of a challenge.

VI. Continue Tracking Water Use

A. Remind students that they should be keeping track of all the water and energy that they are using today.

B. Check students' *Personal Water & Energy Use Logs* to be sure they are being filled in.

Extension Activities

- **Research your city's water supply and water uses.** Find out, either through Internet research or by calling your water agency, information about the supply and demand of water in your area.

- **Investigate droughts in California.** What defines a drought? When was the last one in California? What's the history of droughts in California? How long do they last? What effects do they have on people, on the environment, on the economy? Will there be fewer or more droughts in the future?

- **Research major reservoirs.** For each of the seven major reservoirs in southern California, identify their size, their water source, and the places their water is used.
  - Castaic Lake
  - Diamond Valley Lake
  - Lake Matthews
  - Lake Perris
  - Pyramid Lake
  - Lake Silverwood
  - Lake Skinner

LESSON 3: WATER USE & WATER CHALLENGES

Lesson Overview

Students will:

- determine how water is used in the state of California and in southern California (agriculture, environment, urban)
- discuss the problem of water supply meeting water demand
- analyze their personal water use

Vocabulary

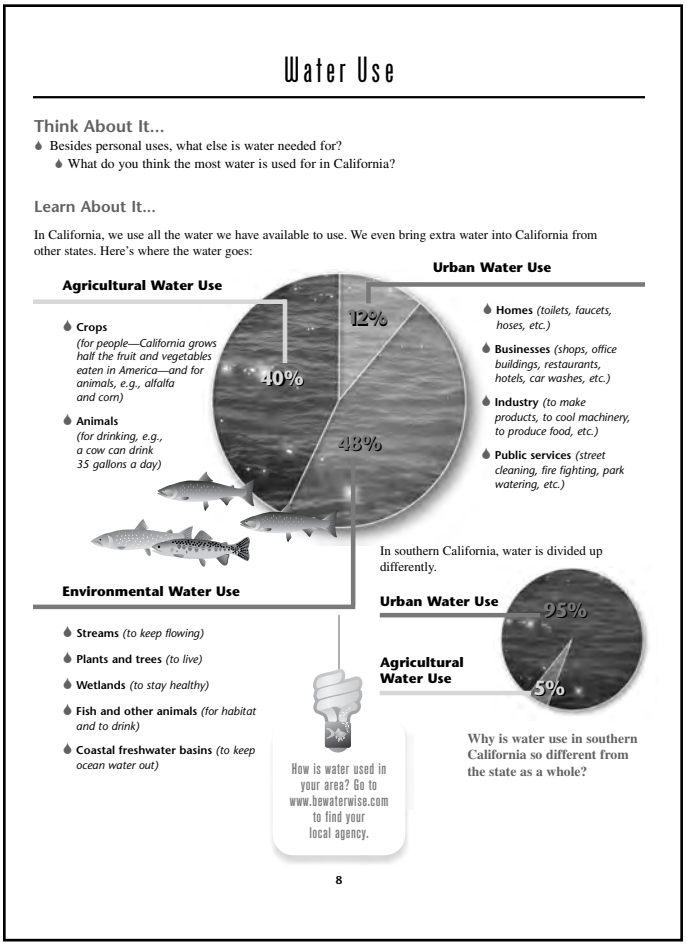
- agriculture
- environment
- urban

Materials and Preparation

- *Conservation Connection* student booklets

Approximate Time Requirement

- 1 to 2 class periods



Water Use

Think About It...

- Besides personal uses, what else is water needed for?
- What do you think the most water is used for in California?

Learn About It...

In California, we use all the water we have available to use. We even bring extra water into California from other states. Here's where the water goes:

Agricultural Water Use

- **Crops** *(for people—California grows half the fruit and vegetables eaten in America—and for animals, e.g., alfalfa and corn)*
- **Animals** *(for drinking, e.g., a cow can drink 35 gallons a day)*

Urban Water Use

- **Homes** *(toilets, faucets, hoses, etc.)*
- **Businesses** *(shops, office buildings, restaurants, hotels, car washes, etc.)*
- **Industry** *(to make products, to cool machinery, to produce food, etc.)*
- **Public services** *(street cleaning, fire fighting, park watering, etc.)*

40% 12% 48%

Environmental Water Use

- **Streams** *(to keep flowing)*
- **Plants and trees** *(to live)*
- **Wetlands** *(to stay healthy)*
- **Fish and other animals** *(for habitat and to drink)*
- **Coastal freshwater basins** *(to keep ocean water out)*

In southern California, water is divided up differently.

Urban Water Use 95%

Agricultural Water Use 5%

How is water used in your area? Go to www.bewaterwise.com to find your local agency.

Why is water use in southern California so different from the state as a whole?

8

Procedures

I. Think About Water Use

A. Have students turn to page 8 in their student booklets—*Water Use.*

B. Read aloud and discuss the questions under **Think About It....**

II. Learn About Water Use

A. Direct students' attention to the large pie graph on page 8. Point out the percentages indicating how much water is needed by each of the sectors in the state. Discuss how water is used within each sector.

B. Tell students to look at the small pie graph on page 8. Explain that this graph shows how water is used in southern California. Ask students:

1. **What differences do you notice in the graphs?**
   Almost all the water goes to urban use in southern California.

2. **Why do you think water use in southern California is so different from the state as a whole?**
   Southern California is almost all homes, industries, and businesses. We have very little agriculture.

C. **(optional)** Divide students into four stakeholder groups:
- agriculture
- environment
- industry and business
- homes and public services

Have each group prepare a brief presentation as to how water is used by their group, why water is so important to their group, and how their group could conserve water.

D. Discuss California's water use by asking students:

1. **In what category are most of your personal uses of water?**
   Personal uses of water are in the urban category.
2. **How does the use of water in each sector affect you?**
   - We eat the food that is grown by agriculture;
   - we use the products that are made by industry;
   - we shop in the stores and use the services of businesses;
   - we depend on fire fighting, street cleaning, and other public services;
   - we depend on the wetlands and freshwater basins for clean water;
   - we eat fish from rivers, streams, and oceans;
   - we enjoy the beauty and other benefits of the environment.
3. **How do you think water use differs from region to region throughout the State?**
   Southern California has a high urban water use; central California has a high agricultural water use; northern California has a high environmental water use.

III. Calculate Personal Water Use

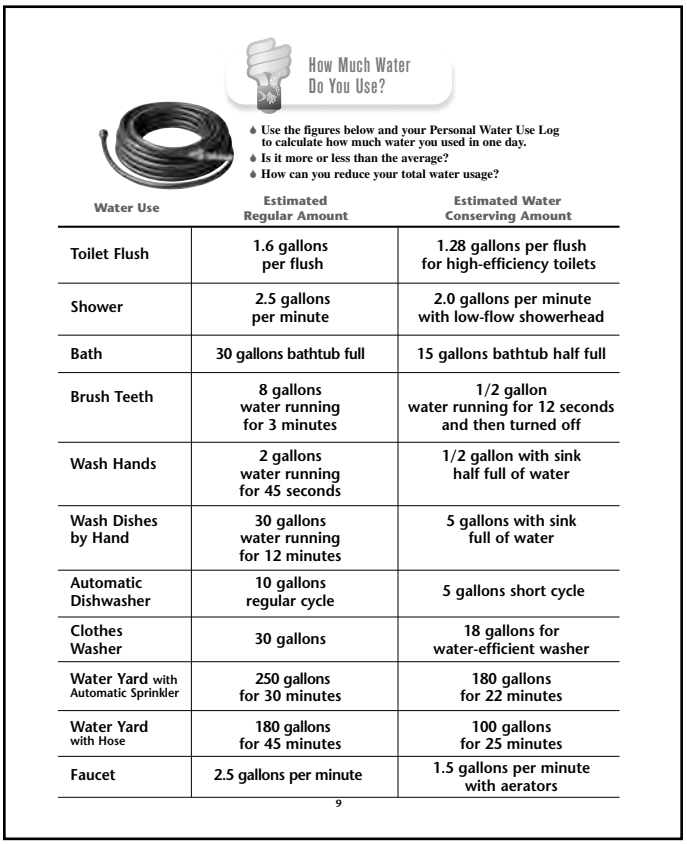
A. Ask students to turn to page 9 in their booklets—*How Much Water Do You Use?* Point out to students that for each use two amounts are shown—a regular amount and a water conserving amount.

B. Have students use the figures shown on this page to fill in the amounts of water for each water use they listed on their ***Personal Water Use Log*** (page 4) and total the number of gallons they used for one day. *(**NOTE:** Estimate the amount of water for any uses not shown.).*

C. Take a quick tally to see what water uses were most common among students and what used the most water. Tell students that:

- indoors, each person in California uses from about 50 gallons to more than 100 gallons of water each day;
- outdoors, on average, each person uses almost another 100 gallons of water each day;
- a family of 5 needs about 326,000 gallons of water a year—that's an acre-foot of water, which is enough to fill a football field a foot deep.

Ask students how their use compares to these figures. Discuss why there might be differences.

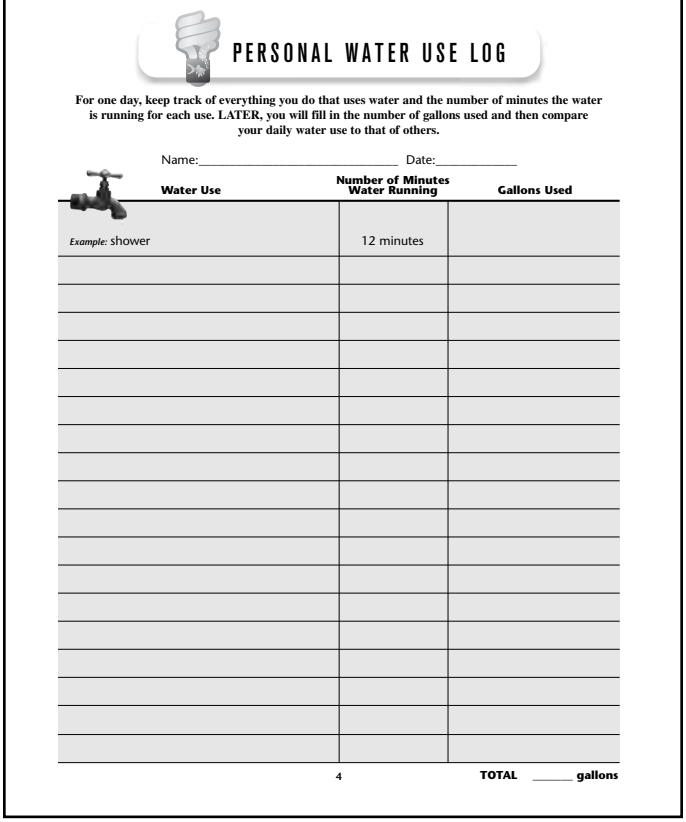


How Much Water Do You Use?

- Use the figures below and your Personal Water Use Log to calculate how much water you used in one day.
- Is it more or less than the average?
- How can you reduce your total water usage?

Water Use	Estimated Regular Amount	Estimated Water Conserving Amount
Toilet Flush	1.6 gallons per flush	1.28 gallons per flush for high-efficiency toilets
Shower	2.5 gallons per minute	2.0 gallons per minute with low-flow showerhead
Bath	30 gallons bathtub full	15 gallons bathtub half full
Brush Teeth	8 gallons water running for 3 minutes	1/2 gallon water running for 12 seconds and then turned off
Wash Hands	2 gallons water running for 45 seconds	1/2 gallon with sink half full of water
Wash Dishes by Hand	30 gallons water running for 12 minutes	5 gallons with sink full of water
Automatic Dishwasher	10 gallons regular cycle	5 gallons short cycle
Clothes Washer	30 gallons	18 gallons for water-efficient washer
Water Yard with Automatic Sprinkler	250 gallons for 30 minutes	180 gallons for 22 minutes
Water Yard with Hose	180 gallons for 45 minutes	100 gallons for 25 minutes
Faucet	2.5 gallons per minute	1.5 gallons per minute with aerators

9



PERSONAL WATER USE LOG

For one day, keep track of everything you do that uses water and the number of minutes the water is running for each use. LATER, you will fill in the number of gallons used and then compare your daily water use to that of others.

Name:_____ Date:_____

Water Use	Number of Minutes Water Running	Gallons Used
Example: shower	12 minutes	

4

TOTAL _____ gallons

IV. Think About Water Challenges

A. Have students turn to page 10 in their booklets—*Water Challenges.*

B. Read aloud and discuss the **Think About It....** question.

Water Challenges

Think About It...

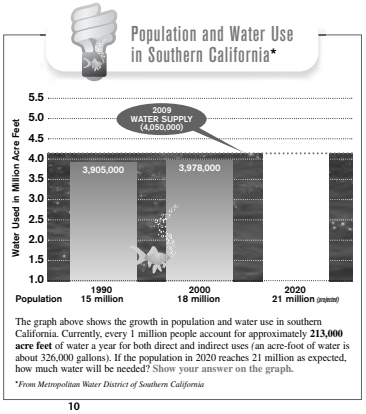
- We have water on the ground and under the ground; we move water to where we need it; we store water for when we need it; we use water over and over. So, what's the problem?

Learn About It...

Providing water to all the people that need it is not a cheap and easy job. And the job is only getting tougher. Why?

- **First, cost.** It is very expensive to build and maintain aqueducts and reservoirs. Water must be pumped along the way and lifted over huge mountains. Great amounts of electricity are used, which costs a lot of money.
- **Second, the environment.** Taking water out of rivers and streams can have negative impacts on the plants and animals that depend on them and on the people that enjoy them. Water companies try to affect the *environment* as little as possible. But even so, large amounts of land are taken up by aqueducts, pumping plants, dams, and reservoirs. And when dams are built to form reservoirs, land is flooded, which obviously affects the people, animals, and plants that live there.
- **Third, population.** More people are being born and more people are moving into California every year. According to California's Department of Finance, the state's population can increase by as much as 500,000 people a year. Thus, more water is needed every year, not just for personal uses but also to build more houses, to grow more food, to make more products, and to generate more electricity.

So where will we get more water?



The graph above shows the growth in population and water use in southern California. Currently, every 1 million people account for approximately **213,000 acre feet** of water a year for both direct and indirect uses (an acre-foot of water is about 326,000 gallons). If the population in 2020 reaches 21 million as expected, how much water will be needed? **Show your answer on the graph.**

**From Metropolitan Water District of Southern California*

10

V. Learn About Water Challenges

A. Have students read the text under **Learn About It...**. Then use the following questions to generate a discussion.

1. **Why is supplying water to everyone that needs it—especially in southern California—so expensive?**
   We import much of our water in southern California, and it is expensive to build and maintain aqueducts, reservoirs, and pumping plants.

2. **How does supplying water affect the environment?**
   Water is pumped from rivers and streams where plants and animals live. And a lot of land is needed for aqueducts, reservoirs, and pumping plants.

3. **What are the costs of supplying water?**
   Costs include building and maintaining aqueducts and reservoirs and paying for a lot of electricity to pump water along the way, especially over huge mountains.

4. **How is the population of California changing and why is that a problem for water supply?**
   The population grows every year, and all those people use water—directly and indirectly.

B. Direct students' attention to the bar graph on page 10 showing the population in southern California and the amount of water used. Ask students to look at the graph and determine:
   - how much water was used in 1990?
   - how much water was used in 2000?
   - what is the water supply in 2009?

C. Read aloud the text under the graph. Have students figure the amount of water that will be needed in 2020 for the projected population and fill in the graph.

213,000 (acre feet of water/one million people)
x 21 (million people)

4,473,000 acre feet of water

D. Point out to students that even though the amount used per person has decreased, by 2020 in southern California we will need more water than we currently have available because of the increase in population. Ask students:
   - So where will we get more water?

Extension Activities

- **Make pictographs showing the various uses of water in each sector.** Locate pictures, or draw them, showing many different uses of water in agriculture, industry, business, homes, cities, the environment.
- **Investigate indirect uses of water**—that is, water that they do not use first-hand but that is needed to make products they use or to provide services they use. How much water is needed for such indirect water uses as: generating electricity, growing wheat to make bread, manufacturing a car, raising a cow, cleaning streets?
- **Begin a water issues file.** Look through newspapers, magazines, and the Internet for articles about water supply in California. Discuss the articles, especially if there are conflicting viewpoints.

LESSON 4: WATER & THE FUTURE

Lesson Overview

Students will:

- learn about ways to stretch our supply of water—recycling, desalination, conservation
- solve math problems related to water use

Vocabulary

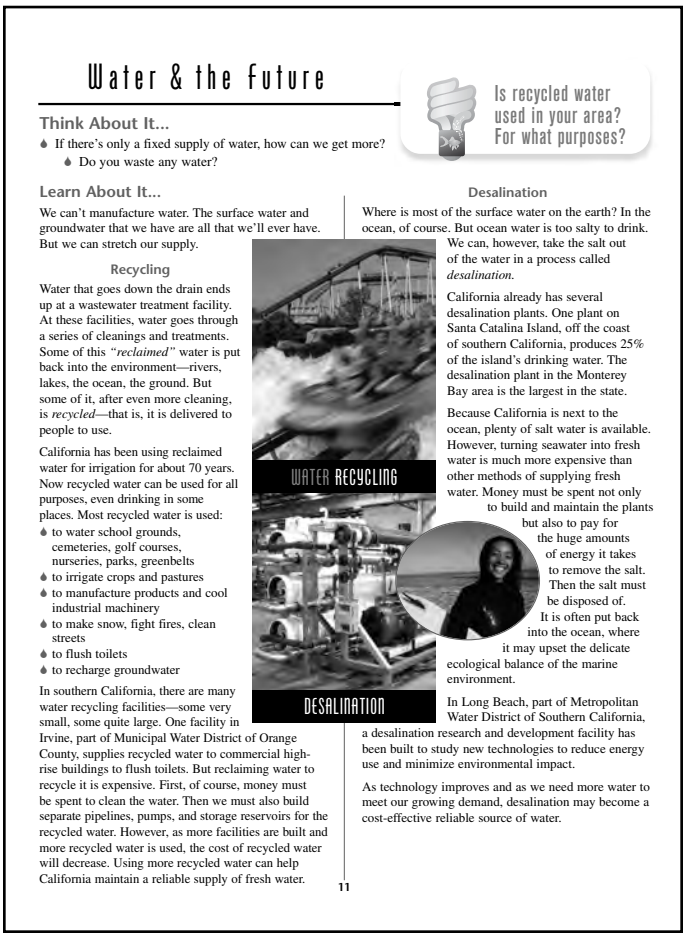
- conservation
- desalination
- drought
- reclaimed water
- recycled water
- technology
- water efficiency

Materials and Preparation

- *Conservation Connection* student booklets
- Materials for recycling demonstration
  - two clear gallon containers
  - a measuring cup
  - water (175 ounces, about 1½ gallons)
- Materials for desalination demonstration
  - teakettle
  - 2 teacups
  - hot plate
  - oven mitt
  - cup of salt water (enough salt added to water to taste the salt)
  - straws

Approximate Time Requirement

- 1 to 2 class periods



Water & the Future

Is recycled water used in your area? For what purposes?

Think About It...

- If there's only a fixed supply of water, how can we get more?
- Do you waste any water?

Learn About It...

We can't manufacture water. The surface water and groundwater that we have are all that we'll ever have. But we can stretch our supply.

Recycling

Water that goes down the drain ends up at a wastewater treatment facility. At these facilities, water goes through a series of cleanings and treatments. Some of this *"reclaimed"* water is put back into the environment—rivers, lakes, the ocean, the ground. But some of it, after even more cleaning, is *recycled*—that is, it is delivered to people to use.

California has been using reclaimed water for irrigation for about 70 years. Now recycled water can be used for all purposes, even drinking in some places. Most recycled water is used:

- to water school grounds, cemeteries, golf courses, nurseries, parks, greenbelts
- to irrigate crops and pastures
- to manufacture products and cool industrial machinery
- to make snow, fight fires, clean streets
- to flush toilets
- to recharge groundwater

In southern California, there are many water recycling facilities—some very small, some quite large. One facility in Irvine, part of Municipal Water District of Orange County, supplies recycled water to commercial high-rise buildings to flush toilets. But reclaiming water to recycle it is expensive. First, of course, money must be spent to clean the water. Then we must also build separate pipelines, pumps, and storage reservoirs for the recycled water. However, as more facilities are built and more recycled water is used, the cost of recycled water will decrease. Using more recycled water can help California maintain a reliable supply of fresh water.

WATER RECYCLING

DESALINATION

Desalination

Where is most of the surface water on the earth? In the ocean, of course. But ocean water is too salty to drink. We can, however, take the salt out of the water in a process called *desalination.*

California already has several desalination plants. One plant on Santa Catalina Island, off the coast of southern California, produces 25% of the island's drinking water. The desalination plant in the Monterey Bay area is the largest in the state.

Because California is next to the ocean, plenty of salt water is available. However, turning seawater into fresh water is much more expensive than other methods of supplying fresh water. Money must be spent not only to build and maintain the plants but also to pay for the huge amounts of energy it takes to remove the salt. Then the salt must be disposed of. It is often put back into the ocean, where it may upset the delicate ecological balance of the marine environment.

In Long Beach, part of Metropolitan Water District of Southern California, a desalination research and development facility has been built to study new technologies to reduce energy use and minimize environmental impact.

As technology improves and as we need more water to meet our growing demand, desalination may become a cost-effective reliable source of water.

11

Procedures

I. Think About Water & the Future

A. Have students open their student booklets to page 11—*Water and The Future.*

B. Read aloud and discuss the questions under **Think About It....**

II. Learn About Recycling

A. Have students read the first paragraph on page 11 under **Learn About It....**

B. Display a clear gallon container and tell students that this container is going to represent the supply of water for homes in their community for a year. Have students fill and mark the container (with tape or marker) as follows:

- add 3 oz., mark the level, and label: DRINKING & COOKING - 3%
- add 5 oz., mark the level, and label: FAUCETS - 5%
- add 11 oz., mark the level, and label: LAUNDRY - 11%
- add 15 oz., mark the level, and label: BATHING - 15%
- add 19 oz., mark the level, and label: TOILETS - 19%
- add 47 oz., mark the level, and label: OUTDOOR USES - 47%

Explain that the percentages indicate the approximate amounts needed by homes in California for each particular use.

C. Ask students:

1. **What needs the most water?**
   Outdoor uses consume the most water.
2. **What uses the most water in the house?**
   Toilets use the most water.
3. **For each use, what happens to the water?**
   - *For toilets, bathing, laundry, and faucet uses, the water goes down the drain, into the sewer, then to the wastewater treatment plant.*
   - *For drinking & cooking, the water is consumed by us.*
   - *For outdoor uses, the water soaks into the ground or evaporates or runs off onto pavement and into storm drains.*

D. Show students the empty container and tell them that it represents the wastewater treatment plant. Have students "dispose" of the water in the first container appropriately—that is:
   - use the water labeled OUTDOOR USES to water plants, or trees, or the lawn
   - pour the water from FAUCETS, LAUNDRY, BATHING, and TOILETS into the empty container (signifying down the drain to the wastewater treatment plant)
   - drink the water labeled DRINKING & COOKING *(if you are sure that the water and the container are clean; otherwise, water a plant)*

E. Tell students that there is a drought and that your community's total supply of water for household uses is now only 3/4 of what it was the year before. Refill the first container with **75 ounces** of clean water.
*(**NOTE:** If instead of a drought, the population increased, the original supply might stay the same – 100 ounces – but the amount needed for each of the uses shown on the container would increase. The resulting effect would be the same.)*

F. Ask students:
   1. **Is there enough water for all the uses?**
      No.
   2. **How could the supply be extended to have enough?**
      Water that went down the drain to the wastewater treatment facility could be recycled to water lawns (even perhaps for drinking with new technology). Also, less water could perhaps be used for some of the other uses.
   3. **Would there be enough water if some of the water in the wastewater container were used?**
      Yes, and some would even be left over.
   4. **Is water recycled?**
      Yes. California has been recycling water to use for irrigation for many years.

G. Have students read the information about "Recycling" in their books on page 11. Discuss:
   - What can recycled water be used for?
   - Why is recycled water sometimes more expensive?

III. Learn About Desalination

A. Ask students:
   1. **Where do you see the most surface water when you look at a world map or globe?**
      Most surface water is in the ocean.
   2. **Why don't we use ocean water?**
      It's too salty.
   3. **Is there any way to take the salt out of the water?**
      Yes. Salt can be removed through desalination.

B. Set up the desalination demonstration:
   1. Pour the cup of salt water into the teakettle.
   2. Ask a student to use a straw to taste a little of the water and tell the rest of the class how it tastes.
   3. Place the teakettle on the hot plate.
   4. Heat the salt water until it boils and turns into steam.
   5. Put on the oven mitt and hold one teacup upside down over the escaping steam from the teakettle so the water vapor collects in the cup.
   6. Place the second teacup underneath so that as the vapor condenses, water will drip into the second cup.
   7. When most of the water has boiled out of the teakettle, have students taste the water that has collected in the teacup.

   Explain that the water has been "distilled," which is one method (though not the one commonly used) to remove salt from water.

C. Have students read the information about "Desalination" in their books on page 11. Discuss:
   1. **Where is desalination being used in California now?**
      Desalination is being used in several places. Large plants are on Santa Catalina Island and in the Monterey Bay area. A research desalination facility has been built in Long Beach.
   2. **Why aren't we desalting more water?**
      Currently, desalination is expensive. And it may upset the ecological balance of the marine environment.

IV. Learn About Conservation

A. Have students read about "Conservation" on page 12 and ask:

1. **Why is conservation a key way to stretch our water supply?**
   Conservation would:
   - *increase our supply at no extra cost*
   - *decrease our costs for distributing water*
   - *decrease our costs for cleaning wastewater*
   - *benefit the environment by taking less fresh water out of it and discharging less wastewater into it.*

2. **What are the two major methods of conserving water?**
   We can conserve water with:
   - *new technologies, such as toilets and washers that use less water*
   - *non-wasteful practices, such as taking shorter showers and planting low water-use plants.*

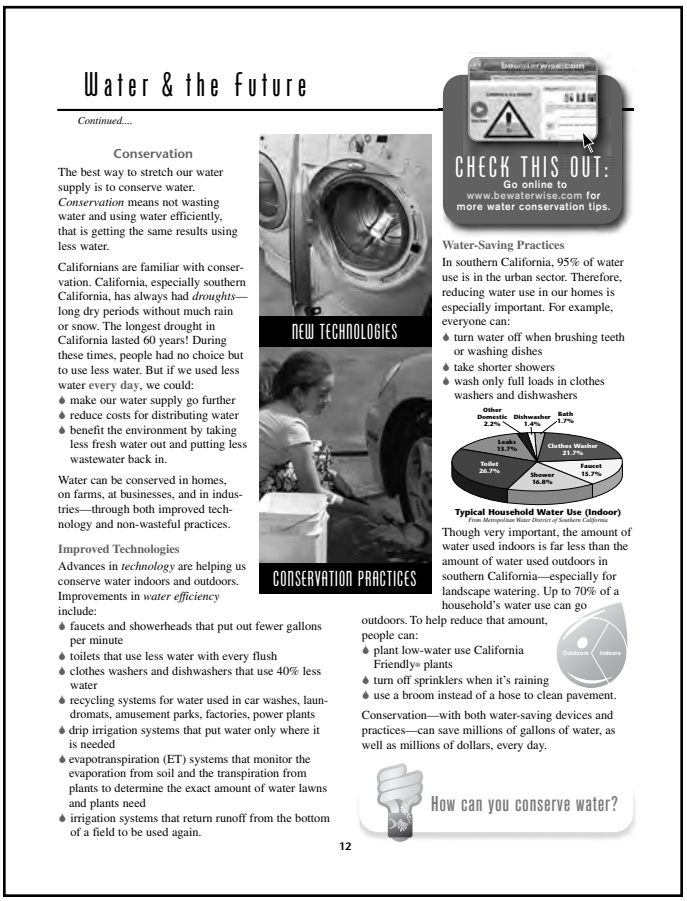
3. **Overall, is more water used indoors or outdoors?**
   More water is used outdoors.

4. **What are some ways to reduce outdoor water use?**
   We can plant low-water use plants, turn sprinklers off in the rain, use a broom instead of a hose.

5. **According to the pie graph, what are the top three uses of water indoors?**
   Toilets, clothes washers, and showers are the top three water users indoors.

B. Have students brainstorm ways to conserve water. Tell them that when they analyze their *Home Water & Energy Surveys* they will learn more about ways to save water.

C. Have students look at the back of their student booklets. Explain that this **Conservation House** depicts many ways to save water. Ask students to point out water conservation practices that they see. Point out the web address on the page **(www.mwdh2o.com/education/conservationhouse)** and tell students that if they go online, they can "scroll" through this water-efficient home to see exactly how water is being saved.



Water & the Future

Continued....

Conservation

The best way to stretch our water supply is to conserve water. *Conservation* means not wasting water and using water efficiently, that is getting the same results using less water.

Californians are familiar with conservation. California, especially southern California, has always had *droughts*—long dry periods without much rain or snow. The longest drought in California lasted 60 years! During these times, people had no choice but to use less water. But if we used less water every day, we could:
- make our water supply go further
- reduce costs for distributing water
- benefit the environment by taking less fresh water out and putting less wastewater back in.

Water can be conserved in homes, on farms, at businesses, and in industries—through both improved technology and non-wasteful practices.

Improved Technologies

Advances in *technology* are helping us conserve water indoors and outdoors. Improvements in *water efficiency* include:
- faucets and showerheads that put out fewer gallons per minute
- toilets that use less water with every flush
- clothes washers and dishwashers that use 40% less water
- recycling systems for water used in car washes, laundromats, amusement parks, factories, power plants
- drip irrigation systems that put water only where it is needed
- evapotranspiration (ET) systems that monitor the evaporation from soil and the transpiration from plants to determine the exact amount of water lawns and plants need
- irrigation systems that return runoff from the bottom of a field to be used again.

NEW TECHNOLOGIES

CONSERVATION PRACTICES

CHECK THIS OUT:
Go online to www.bewaterwise.com for more water conservation tips.

Water-Saving Practices

In southern California, 95% of water use is in the urban sector. Therefore, reducing water use in our homes is especially important. For example, everyone can:
- turn water off when brushing teeth or washing dishes
- take shorter showers
- wash only full loads in clothes washers and dishwashers

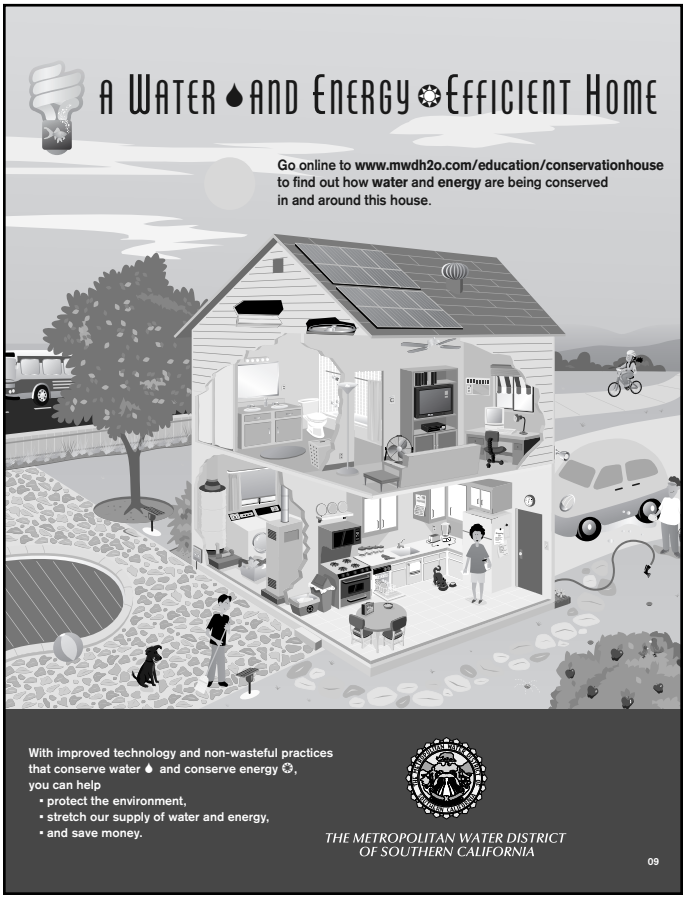
Typical Household Water Use (Indoor)
From Metropolitan Water District of Southern California

Though very important, the amount of water used indoors is far less than the amount of water used outdoors in southern California—especially for landscape watering. Up to 70% of a household's water use can go outdoors. To help reduce that amount, people can:
- plant low-water use California Friendly® plants
- turn off sprinklers when it's raining
- use a broom instead of a hose to clean pavement.

Conservation—with both water-saving devices and practices—can save millions of gallons of water, as well as millions of dollars, every day.

How can you conserve water?

12



A WATER AND ENERGY EFFICIENT HOME

Go online to **www.mwdh2o.com/education/conservationhouse** to find out how **water** and **energy** are being conserved in and around this house.

With improved technology and non-wasteful practices that conserve water and conserve energy, you can help
- protect the environment,
- stretch our supply of water and energy,
- and save money.

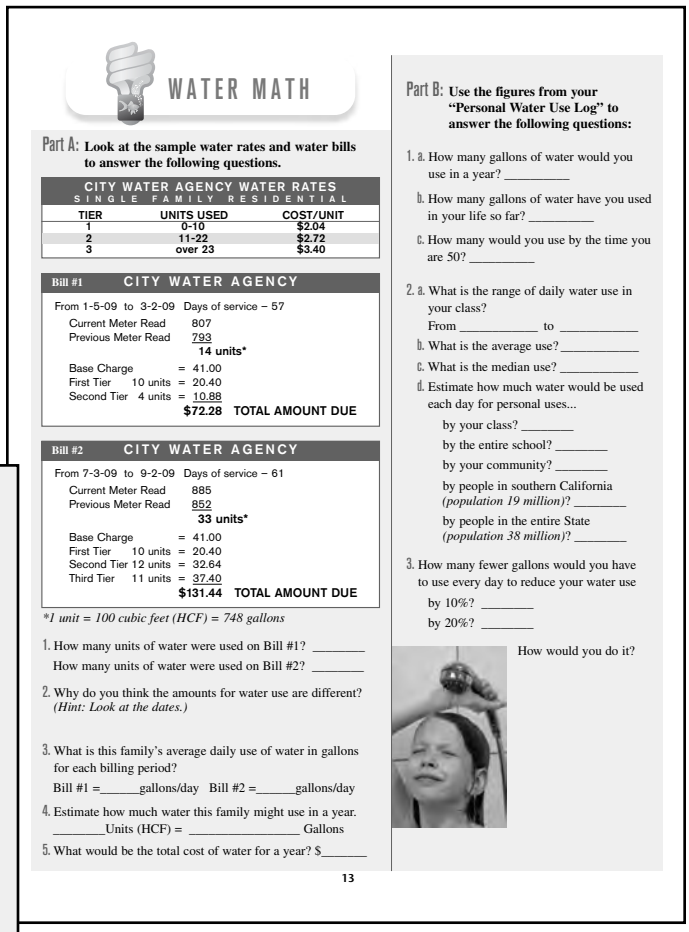
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

09

V. Solve Math Problems

A. Have students turn to page 13 in their booklets—*Water Math.* Read the directions for Parts A and B aloud and have students work on the problems either:
- individually
- in pairs or groups
- together as a class *(especially #2 in Part B)*

B. Correct the exercise with the class, working through the problems and discussing the answers.



WATER MATH

Part A: **Look at the sample water rates and water bills to answer the following questions.**

CITY WATER AGENCY WATER RATES
SINGLE FAMILY RESIDENTIAL

TIER	UNITS USED	COST/UNIT
1	0-10	$2.04
2	11-22	$2.72
3	over 23	$3.40

Bill #1 CITY WATER AGENCY

From 1-5-09 to 3-2-09 Days of service – 57
Current Meter Read 807
Previous Meter Read 793
14 units*
Base Charge = 41.00
First Tier 10 units = 20.40
Second Tier 4 units = 10.88
$72.28 TOTAL AMOUNT DUE

Bill #2 CITY WATER AGENCY

From 7-3-09 to 9-2-09 Days of service – 61
Current Meter Read 885
Previous Meter Read 852
33 units*
Base Charge = 41.00
First Tier 10 units = 20.40
Second Tier 12 units = 32.64
Third Tier 11 units = 37.40
$131.44 TOTAL AMOUNT DUE

**1 unit = 100 cubic feet (HCF) = 748 gallons*

1. How many units of water were used on Bill #1? _____
How many units of water were used on Bill #2? _____
2. Why do you think the amounts for water use are different? *(Hint: Look at the dates.)*
3. What is this family's average daily use of water in gallons for each billing period?
Bill #1 =_____gallons/day Bill #2 =_____gallons/day
4. Estimate how much water this family might use in a year.
_____Units (HCF) = _____ Gallons
5. What would be the total cost of water for a year? $_____

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Part B: **Use the figures from your "Personal Water Use Log" to answer the following questions:**

1. a. How many gallons of water would you use in a year? _____
b. How many gallons of water have you used in your life so far? _____
c. How many would you use by the time you are 50? _____

2. a. What is the range of daily water use in your class?
From _____ to _____
b. What is the average use? _____
c. What is the median use? _____
d. Estimate how much water would be used each day for personal uses...
by your class? _____
by the entire school? _____
by your community? _____
by people in southern California *(population 19 million)*? _____
by people in the entire State *(population 38 million)*? _____

3. How many fewer gallons would you have to use every day to reduce your water use
by 10%? _____
by 20%? _____
How would you do it?

**1 unit = 100 cubic feet (HCF) = 748 gallons*

1. How many units of water were used on Bill #1? **14**
How many units of water were used on Bill #2? **33**
2. Why do you think the amounts for water use are different? *(Hint: Look at the dates.)*
Bill #1 is for winter months. Bill #2 is for summer months.
3. What is this family's average daily use of water in gallons for each billing period? **(# units x 748 gallons ÷ days of service)**
Bill #1 = **183.7** gallons/day Bill #2 = **404.6** gallons/day
4. Estimate how much water this family might use in a year.
~141 Units (HCF) = **105,468** Gallons
5. What would be the total cost of water for a year? $**~611**

♦ Extension Activities

- **Research proposals to reduce water use.** Find out about the Governor's Executive Order to reduce urban water use by 20% by 2020. What legislation or other proposals have been presented to meet that order? What would you propose?
- **Conduct a shower versus bath experiment** Have all students who have bathtubs at home fill their tubs to take a bath, but tell them that before they get in the tub to measure the depth of water. Make a chart in class recording the various depths of water. Next, tell students to take a shower in the same bathtub, but before they begin they should close the bathtub drain so that the water will collect in the tub. Tell them to time their shower and to measure the depth of water that has collected in the tub when they are finished. Record the figures on the chart and compare.
- **Research conservation products and report on water savings.** Determine an average cost for various new water-saving products (e.g., Energy Star washing machine, WaterSense toilet, low-flow showerhead). Then, calculate how much water is saved and how long the product will take to "pay for itself"—that is, even though a new water-efficient product may be more expensive to buy, it costs less to operate, so how long will it take to make up the extra cost to purchase the product?
- **Research and design a graywater reclamation system.** Find out how various designs work for recycling water at home, what regulations must be followed, and what problems might exist? Have the class work in teams to research city regulations and design a system for a new home that is being built.
- **Research the economics of recycling water.** Compare using recycled water to using imported water. What are the differences in cost? What are the advantages and disadvantages of each?

LESSON 5: ENERGY SOURCES

✪ Lesson Overview

Students will:

- prepare and give presentations on the various energy sources we currently use
- compare the advantages and disadvantages of energy sources

✪ Vocabulary

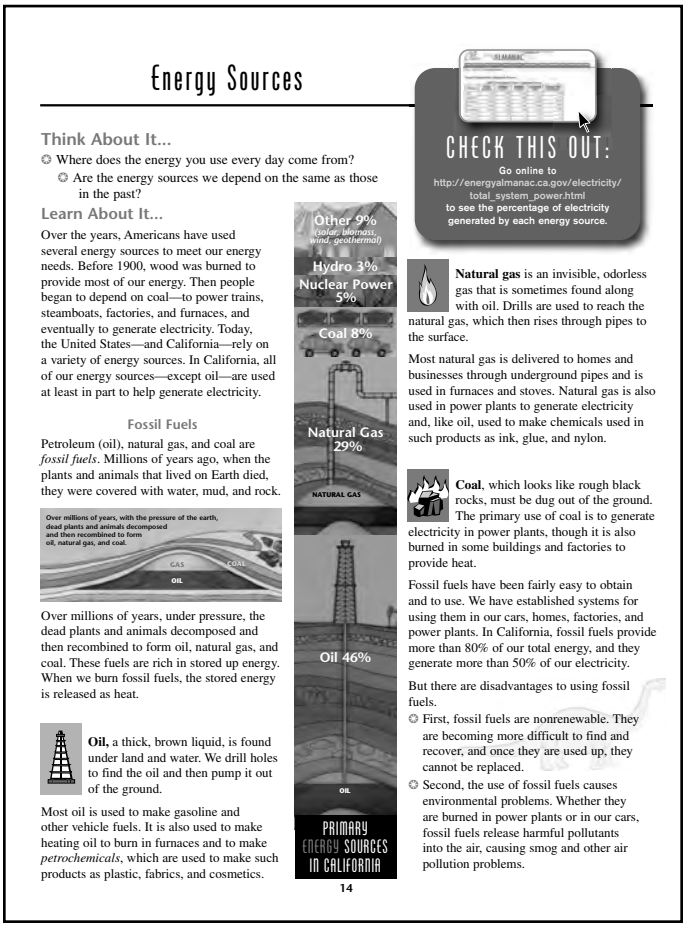
- atom
- biofuel
- biomass
- fission
- fossil fuels
- geothermal
- hydropower
- neutrons
- nuclear power
- nucleus
- petrochemicals
- photovoltaic
- solar energy
- thermal heat
- turbine-generator
- uranium

✪ Materials and Preparation

- *Conservation Connection* student booklets
- Materials to make posters

✪ Approximate Time Requirement

- 2-3 class periods, depending on time to prepare and give presentations



Energy Sources

Think About It...

✪ Where does the energy you use every day come from?

✪ Are the energy sources we depend on the same as those in the past?

Learn About It...

Over the years, Americans have used several energy sources to meet our energy needs. Before 1900, wood was burned to provide most of our energy. Then people began to depend on coal—to power trains, steamboats, factories, and furnaces, and eventually to generate electricity. Today, the United States—and California—rely on a variety of energy sources. In California, all of our energy sources—except oil—are used at least in part to help generate electricity.

Fossil Fuels

Petroleum (oil), natural gas, and coal are *fossil fuels*. Millions of years ago, when the plants and animals that lived on Earth died, they were covered with water, mud, and rock.

Over millions of years, with the pressure of the earth, dead plants and animals decomposed and then recombined to form oil, natural gas, and coal.

GAS COAL OIL

Over millions of years, under pressure, the dead plants and animals decomposed and then recombined to form oil, natural gas, and coal. These fuels are rich in stored up energy. When we burn fossil fuels, the stored energy is released as heat.

Oil, a thick, brown liquid, is found under land and water. We drill holes to find the oil and then pump it out of the ground.

Most oil is used to make gasoline and other vehicle fuels. It is also used to make heating oil to burn in furnaces and to make *petrochemicals*, which are used to make such products as plastic, fabrics, and cosmetics.

Other 9% (solar, biomass, wind, geothermal)
Hydro 3%
Nuclear Power 5%
Coal 8%
Natural Gas 29%
NATURAL GAS
Oil 46%
OIL

PRIMARY ENERGY SOURCES IN CALIFORNIA

CHECK THIS OUT:

Go online to http://energyalmanac.ca.gov/electricity/total_system_power.html to see the percentage of electricity generated by each energy source.

Natural gas is an invisible, odorless gas that is sometimes found along with oil. Drills are used to reach the natural gas, which then rises through pipes to the surface.

Most natural gas is delivered to homes and businesses through underground pipes and is used in furnaces and stoves. Natural gas is also used in power plants to generate electricity and, like oil, used to make chemicals used in such products as ink, glue, and nylon.

Coal, which looks like rough black rocks, must be dug out of the ground. The primary use of coal is to generate electricity in power plants, though it is also burned in some buildings and factories to provide heat.

Fossil fuels have been fairly easy to obtain and to use. We have established systems for using them in our cars, homes, factories, and power plants. In California, fossil fuels provide more than 80% of our total energy, and they generate more than 50% of our electricity.

But there are disadvantages to using fossil fuels.

✪ First, fossil fuels are nonrenewable. They are becoming more difficult to find and recover, and once they are used up, they cannot be replaced.

✪ Second, the use of fossil fuels causes environmental problems. Whether they are burned in power plants or in our cars, fossil fuels release harmful pollutants into the air, causing smog and other air pollution problems.

14

✪ Procedures

I. Think About Energy Sources

A. Have students open their student booklets to page 14, *Energy Sources.*

B. Read aloud and discuss the questions under **Think About It....**

II. Prepare Student Presentations

A. Have students read the first paragraph on page 14 under **Learn About It....**

B. Tell students that to learn more about our energy resources, each of them is going to become an "expert" about a certain energy source and will then inform the rest of the class about that source.

C. Divide the class into 8 groups, one for each of the energy sources described in their books on pages 14-18:

- fossil fuels
- nuclear power
- hydropower
- solar
- biomass
- geothermal
- wind
- ocean energy

D. Explain that each group should use the information in their books plus whatever other information they gather to become "experts" about their energy source. Tell students that each group is to prepare a poster and a brief report about their source but they can also use other methods and other media to present their information to the rest of the class.

E. Inform students how long you are giving them to prepare their presentations, when they will give their presentations, and about how long each presentation should be.

III. Conduct Presentations

A. Ask students to turn in their booklets to page 19—*Compare Energy Sources.* Explain that as they listen to each presentation, they should fill in the worksheet indicating the advantages and disadvantages of each energy source. Tell them to pay particular attention to the areas of cost, supply, and environmental effects.

B. Have each "expert" group present their poster and information about their energy source. After each presentation, ask the class if they have any questions to ask the experts.

C. Display the posters around the room.

IV. Compare Energy Sources

A. When all the presentations have been completed, discuss the energy source comparison worksheet using the sample responses below as a guide.

B. Point out to students that every energy source has advantages and disadvantages and that meeting our energy needs is not easy.

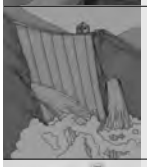
C. Ask students what energy sources they think should be developed in the future and why.

SAMPLE RESPONSES

COMPARE ENERGY SOURCES

What are some advantages and disadvantages of each of our energy sources?

Think about: **supply** **cost** **environmental effects**

Energy Source	Advantages	Disadvantages
 **fossil fuels**	*Fairly easy to obtain and to use* *Systems in place to use them in our cars, homes, factories, and power plants*	*Nonrenewable* *Dependence on other countries for the amount we use* *Becoming more difficult to find and get out of the ground so costs continue to increase* *Contribute to air pollution*
 **nuclear power**	*Large supply since uranium, the fuel, is a common mineral found around the world* *Not expensive because uranium is common*	*Radioactive waste, which can be harmful to us*
 **hydropower**	*Renewable* *Don't have to pay for water* *Clean for the environment*	*Only a limited number of places with water that can be used for hydropower*
 **solar**	*Renewable* *Don't have to pay for sunshine* *Clean for the environment*	*Not reliable since the sun doesn't always shine* *Needs special power plants and special equipment—solar cells and solar collectors*
 **biomass**	*Renewable* *Inexpensive fuel (trash and plant waste)* *Reduced air emissions from vehicles using biofuels*	*Pollutants released into the air when trash is burned* *Requires a lot of land and water to grow crops for fuel*
 **geothermal**	*Renewable* *Don't have to pay for fuel* *Clean for the environment*	*Only in areas where heat is close to the surface* *Costs to build special power plants and to reinject water into the ground*
 **wind**	*Renewable* *Don't have to pay for wind* *Clean for the environment*	*Not reliable since winds must blow at a constant high speed* *Uses large areas of land and may disturb wildlife*
 **ocean energy**	*Renewable*	*Limited locations* *Possible effects on aquatic plants and animals*

✪ Extension Activities

- **Identify fossil fuel products.** Remind students that fossil fuels are used to make chemicals that are used to produce many products that we use every day. Give students a few examples of fossil fuels products:
  - Plastic—bags, bottles, balls, toothbrushes, dishes, furniture
  - Fabric—polyester, nylon, vinyl
  - Medicine—cough syrup, aspirin
  - Cosmetics—hand lotion, nail polish, shampoo
  - Other products—floor wax, glue, film, ink, insect spray

  Have students identify various objects around the classroom that are made from fossil fuels.

- **Play "What Am I?"** Divide students into two (or more) teams. Either alternate having the teams answer or pose the question to all teams and allow the first team that raises a hand (or rings a bell or calls a name) to answer. State various facts, including advantages and disadvantages, about an energy source and have students guess the source. For example: "I'm renewable; I do not create air pollution; I use falling water to create electricity." *(hydropower)*

- **Make a solar collector.** Gather the following materials: black plastic trash bag, rubber hose about 2 or 3 feet long, thick rubber band, string, water. Tell students that they are going to make a solar collector to heat water.
  - Fill the plastic bag about half full with water.
  - Insert one end of the rubber hose into the top of the bag and secure the bag around the hose with the rubber band.
  - Tie the string tightly around the plastic bag just under the end of the hose in the bag.
  - Lay the bag in the sun for at least one hour.
  - Hold the bag upside down. Untie the string around the bag and carefully feel the water than runs out through the hose.

- **Measure and compare wind speed**. Find the windiest spot at your school and use an anemometer to measure the wind speed at various heights, times of day, times of year. Is it ever windy enough for a wind machine, which requires an average wind speed of 13 miles per hour?

- **Demonstrate a turbine**. Use a toy pinwheel (or construct a metal pinwheel out of a can lid) to demonstrate how the blades are turned by steam, falling water, and wind.

LESSON 6: ENERGY USE & ENERGY CHALLENGES

❂ Lesson Overview

Students will:

- determine how energy is used in California
- discuss the problem of energy supply meeting energy demand
- analyze their personal energy use

❂ Vocabulary

- BTU
- kilowatt hour (kWh)

❂ Materials and Preparation

- *Conservation Connection* student booklets

❂ Approximate Time Requirement

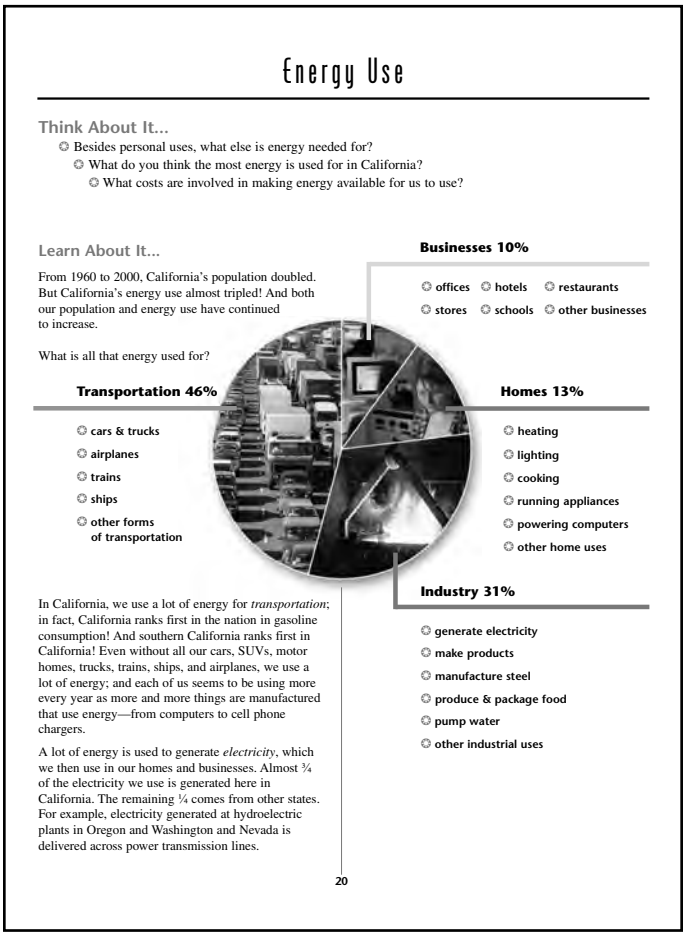
- 1 class period

❂ Procedures

I. Think About Energy Use

A. Have students look at page 20 in their student booklets—*Energy Use.*

B. Read aloud and discuss the questions under **Think About It....**



Energy Use

Think About It...

❂ Besides personal uses, what else is energy needed for?
❂ What do you think the most energy is used for in California?
❂ What costs are involved in making energy available for us to use?

Learn About It...

From 1960 to 2000, California's population doubled. But California's energy use almost tripled! And both our population and energy use have continued to increase.

What is all that energy used for?

Businesses 10%
❂ offices ❂ hotels ❂ restaurants
❂ stores ❂ schools ❂ other businesses

Transportation 46%
❂ cars & trucks
❂ airplanes
❂ trains
❂ ships
❂ other forms of transportation

Homes 13%
❂ heating
❂ lighting
❂ cooking
❂ running appliances
❂ powering computers
❂ other home uses

Industry 31%
❂ generate electricity
❂ make products
❂ manufacture steel
❂ produce & package food
❂ pump water
❂ other industrial uses

In California, we use a lot of energy for *transportation*; in fact, California ranks first in the nation in gasoline consumption! And southern California ranks first in California! Even without all our cars, SUVs, motor homes, trucks, trains, ships, and airplanes, we use a lot of energy; and each of us seems to be using more every year as more and more things are manufactured that use energy—from computers to cell phone chargers.

A lot of energy is used to generate *electricity*, which we then use in our homes and businesses. Almost ¾ of the electricity we use is generated here in California. The remaining ¼ comes from other states. For example, electricity generated at hydroelectric plants in Oregon and Washington and Nevada is delivered across power transmission lines.

20

II. Learn About Energy Use

A. Read aloud the paragraphs under **Learn About It...**. Emphasize that:

"From 1960 to 2000, California's population doubled. But California's energy use almost tripled!"

Point out that means each person is using more energy. Ask students why they think that's true. *(We have more products—more technologies—that use energy; we have bigger houses; we drive more; etc.)*

B. Direct students' attention to the graph on page 20. Ask:

1. **In what categories are you responsible for the use of energy?**
   *All of them. We use energy both **directly** and **indirectly.** We personally use energy in our homes. We attend school and shop in stores. We use products that are made by industry. And we ride in cars, buses, trains, and/or airplanes, as well as use products that are transported by ships, trucks, trains, and planes.*

2. **What provides the energy needed in each sector?**
   The transportation sector uses mainly oil, which is made into gasoline and other fuels. Homes, businesses, and industries depend mostly on natural gas and on electricity.

3. **What energy sources are used to generate electricity?**
   (**NOTE:** Have students go to the website shown in their booklets on page 14 to find out—and then perhaps graph—how much electricity each source generates in California.)

   In California, electricity is generated by:
   - *natural gas – about 46%*
   - *coal – about 18%*
   - *hydropower – about 12%*
   - *nuclear power – about 15%*
   - *geothermal – about 5%*
   - *biomass – about 2%*
   - *wind – about 2%*
   - *solar – less than 1%*
   - *ocean energy – 0%*

III. Calculate Personal Energy Use

A. Tell students that they are going to fill in the numbers to show how much energy they used for everything they listed on their ***Personal Energy Use Log.***

B. Ask students to turn to page 21 in their booklets—*How Much Energy Do You Use?* Point out to students that:

- The amount of energy used by electric appliances is measured in watts. Our use of electricity is measured by kilowatt hours. One kilowatt-hour (kWh) is 1,000 watts of electricity use for one hour. That would be the same as a 1,000 watt hair dryer used for one hour, or a 100 watt incandescent light bulb burning for 10 hours.
- The amount of energy used by appliances that run on natural gas is measured in BTU, which stands for British Thermal Units. One BTU signifies the quantity of heat needed to raise the temperature of one pound of water by 1 degree Fahrenheit; it is a very small unit.

*(**Note:** These definitions are shown on the bottom of page 5—Personal Energy Use Log.)*

C. Ask students to look at the list on page 21 and determine what the top six energy users are and what they have in common. *(The top six energy users—central air conditioner, clothes dryer, furnace, oven, refrigerator, and water heater—all provide either heat or cooling.)*

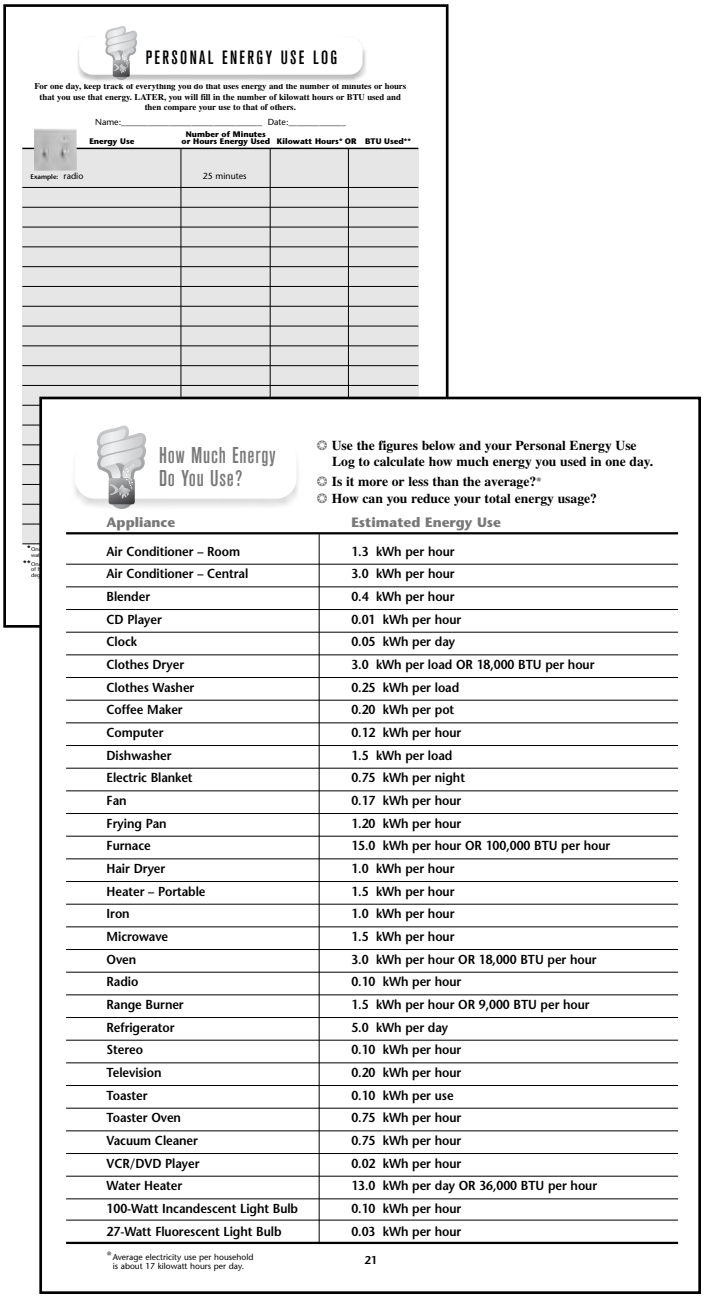
D. Have students use the figures shown on page 21 to fill in the number of kWh for each electrical use they listed on their ***Personal Energy Use Log*** (page 5). Tell them that if any of their appliances—furnace, clothes dryer, water heater, or stove—uses natural gas instead of electricity, they should fill in the BTU figure. *(**NOTE**: If students aren't sure, just have them use the kWh figure.)* For any uses not shown, have students estimate the number based on figures for other uses.

E. Have students figure the total number of kilowatt hours and BTU they used for one day. *(**Note**: You can convert all numbers to kWh using this formula: 3,413 BTU = 1 kWh.)*

F. Add up the total numbers used by the class and divide by the number of students in the class to determine the average amount used per person.

G. Tell students that the average electricity use **per household** is calculated to be about 17 kilowatt hours per day. Explain that in a household, often several people at the same time use the same light, watch the same television, use the same heater, and so on, so individual use varies widely. Remind students that each person is responsible for not only direct energy usage but also indirect usage—the energy needed to make the products and grow the food that each of us uses.

H. Take a quick tally to see what energy uses were most common among students and what the range of use is in the class.



PERSONAL ENERGY USE LOG

For one day, keep track of everything you do that uses energy and the number of minutes or hours that you use that energy. LATER, you will fill in the number of kilowatt hours or BTU used and then compare your use to that of others.

Name:_____ Date:_____

Energy Use	Number of Minutes or Hours Energy Used	Kilowatt Hours* OR	BTU Used**
Example: radio	25 minutes		

How Much Energy Do You Use?

- Use the figures below and your Personal Energy Use Log to calculate how much energy you used in one day.
- Is it more or less than the average?*
- How can you reduce your total energy usage?

Appliance	Estimated Energy Use
Air Conditioner – Room	1.3 kWh per hour
Air Conditioner – Central	3.0 kWh per hour
Blender	0.4 kWh per hour
CD Player	0.01 kWh per hour
Clock	0.05 kWh per day
Clothes Dryer	3.0 kWh per load OR 18,000 BTU per hour
Clothes Washer	0.25 kWh per load
Coffee Maker	0.20 kWh per pot
Computer	0.12 kWh per hour
Dishwasher	1.5 kWh per load
Electric Blanket	0.75 kWh per night
Fan	0.17 kWh per hour
Frying Pan	1.20 kWh per hour
Furnace	15.0 kWh per hour OR 100,000 BTU per hour
Hair Dryer	1.0 kWh per hour
Heater – Portable	1.5 kWh per hour
Iron	1.0 kWh per hour
Microwave	1.5 kWh per hour
Oven	3.0 kWh per hour OR 18,000 BTU per hour
Radio	0.10 kWh per hour
Range Burner	1.5 kWh per hour OR 9,000 BTU per hour
Refrigerator	5.0 kWh per day
Stereo	0.10 kWh per hour
Television	0.20 kWh per hour
Toaster	0.10 kWh per use
Toaster Oven	0.75 kWh per hour
Vacuum Cleaner	0.75 kWh per hour
VCR/DVD Player	0.02 kWh per hour
Water Heater	13.0 kWh per day OR 36,000 BTU per hour
100-Watt Incandescent Light Bulb	0.10 kWh per hour
27-Watt Fluorescent Light Bulb	0.03 kWh per hour

*Average electricity use per household is about 17 kilowatt hours per day.

21

IV. Think About Energy Challenges

A. Have students turn to page 22 in their booklets—*Energy Challenges.*

B. Read aloud and discuss the question under **Think About It...**.

Energy Challenges

Think About It...

❂ We get energy from many sources—nonrenewable and renewable. So what's the problem?

Learn About It...

Energy comes in many forms—and we depend on it to live our lives. But there are challenges to getting—and using—the energy we need. What are those challenges?

❂ First, supply.

The amount of energy we have doesn't always match the amount we need. In the 1970s, the "energy crisis" had people waiting in long lines and paying high prices to buy gasoline, sometimes only on specified days. In 2008, prices rose dramatically again. Because we depend on other countries for much of the oil we need to manufacture gasoline, our supply is not always certain.

In 2001, the "energy crisis" caused "rolling blackouts" throughout California, meaning that various areas were without electricity for periods of time. Along with other factors, the shortage of electricity was caused by:

- more demand during hot summer weather
- less supply from the hydroelectric plants in the Pacific Northwest where rainfall was low.

❂ Second, the environment.

Most of our energy comes from burning fossil fuels, which emit pollutants into our air. Especially in southern California, these pollutants cause smog. In other parts of the country, fossil fuels also contribute to acid rain; and in the world they are causing climate changes, which can have many negative effects—such as polar ice melting, which could lead to rising sea levels and flooded coastal areas;

more hurricanes and tornadoes; increased number of droughts; and changes in forests, crop lands, coral reefs, and wildlife habitats.

Other energy sources also impact the environment—whether taking up space, flooding land behind dams, disrupting wildlife, or creating radioactive waste. The more energy we use, the more the environment is affected.

❂ Third, money.

It's expensive to supply the energy we need. Fossil fuels must be drilled for or dug out of the ground and transported to where they are needed; power plants must be built; transmission lines must be connected. When we import energy, even more money must be spent. As the demand goes up and our supply goes down, consumers will be spending even more each month for the energy they use.

❂ Fourth, population.

California is the fastest growing state in the nation.

- In 2008, our population was approximately 38 million.
- By 2050, it is projected to be 55 million.

Energy will be needed to make the products and distribute the water consumed by all these people. And, of course, each person will use energy every day just to live their lives.

So how will we have enough energy for the future?

22

V. Learn About Energy Challenges

A. Have students read the text under **Learn About It...**. Then use the following questions to generate a discussion.

1. **What is an "energy crisis"?**
   An "energy crisis" happens when our supply doesn't meet our demand for energy—such as when we don't get enough oil from other countries or when we can't generate all the electricity that people want to use.
2. **How does using energy affect the environment?**
   Burning fossil fuels, which supply most of our energy in the U.S. and in southern California, puts pollutants into our air—causing smog. Some of these pollutants also are causing climate changes, which can melt polar ice, increase storms and droughts, and affect plant and animal habitats.
3. **What are some reasons that energy is expensive?**
   We buy most of our oil, which we use for transportation, from other countries. And we have to build and maintain power plants and transmission lines and pipelines.
4. **With our increasing population, how will we have enough energy for the future?**
   Allow students to share their ideas.

❂ Extension Activities

- **Demonstrate air pollution**. Gather the following materials: white porcelain cup or plate, candle, matches. Tell students that you are going to demonstrate how fossil fuels produce pollution.
  - Light the candle. Explain that the candle is made, in part, from oil, a fossil fuel.
  - Ask students what they think will happen if the cup or plate is placed over the flame.
  - Briefly place the cup or plate near the top of the flame until a black smudge appears; then remove the cup from the flame.
  - Wipe off part of the black soot with a tissue to show that the cup was not burned or scorched. Ask students why they think the cup turned black.
  - Tell students that burning the candle releases hot gases and tiny particles—air emissions—which rise quickly up into the air. Explain that some of the emissions are invisible and some can be seen as smoke and that when the smoke settles on a surface, it produces soot.
  - Tell students that burning a candle produces very few air emissions; but burning fossil fuels in cars, power plants, factories, and other buildings produces a lot of air emissions that can cause air pollution.
- **Read electric and natural gas bills.** Show students an electricity bill and a natural gas bill and determine the cost per kilowatt hour of electricity and cost per unit of natural gas. Point out that natural gas is usually billed in therms and that one therm equals 100,000 BTU.
- **Determine costs.** Use the following formula to figure the cost of using various electrical appliances:

  Watts x Hours Used x Cost per kWh = Operating Cost

LESSON 7: ENERGY & THE FUTURE

❂ Lesson Overview

Students will:

- learn about ways to meet our energy demand in the future, including energy efficient products, renewables, fuel cells, and conservation
- solve math problems related to energy use

❂ Vocabulary

- energy efficiency
- fuel cell
- sustainable

❂ Materials and Preparation

- *Conservation Connection* student booklets

❂ Approximate Time Requirement

- 1 class period

❂ Procedures

I. Think About Energy & the Future

A. Have students open their student booklets to page 23—*Energy & the Future.*

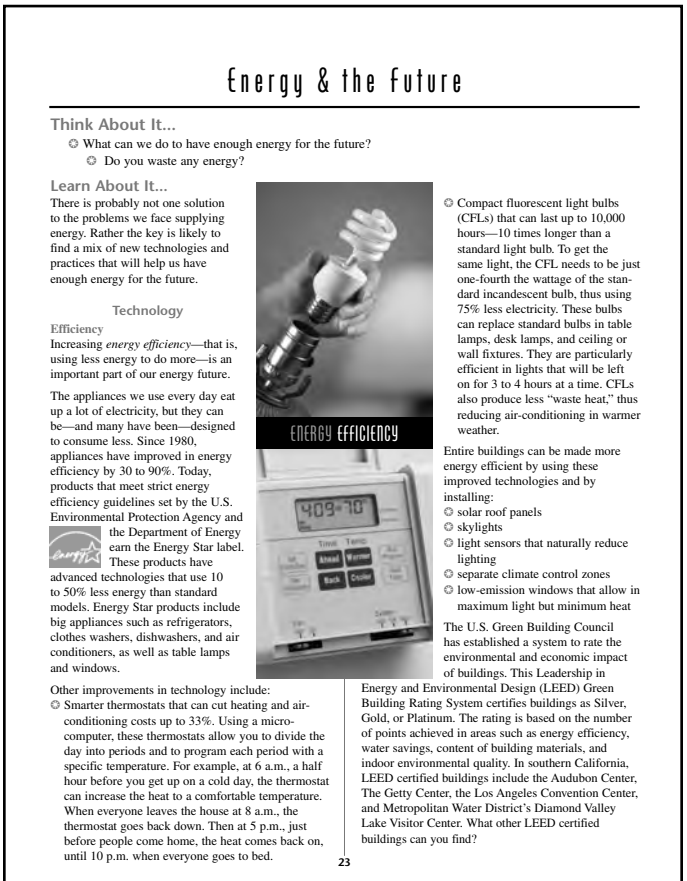
B. Read aloud and discuss the questions under **Think About It....**

II. Learn About Energy Technology and Conservation

A. Read aloud the first paragraph under **Learn About It...** on page 23.

B. Have students read the text on pages 23 and 24. Then use the questions below to discuss what they read.

1. **What does it mean to increase energy efficiency?**
   It means using less energy to do the same or more work.
2. **Are appliances today more or less efficient than in the past?**
   Appliances today are more efficient. Since 1980, appliances—such as refrigerators, dishwashers, clothes dryers—have improved in energy efficiency by 30 to 90%, depending on the product. Today, Energy Star rated products have advanced technologies that use 10 to 15% less energy than standard models.



Energy & the Future

Think About It...

❂ What can we do to have enough energy for the future?

❂ Do you waste any energy?

Learn About It...

There is probably not one solution to the problems we face supplying energy. Rather the key is likely to find a mix of new technologies and practices that will help us have enough energy for the future.

Technology

Efficiency

Increasing *energy efficiency*—that is, using less energy to do more—is an important part of our energy future.

The appliances we use every day eat up a lot of electricity, but they can be—and many have been—designed to consume less. Since 1980, appliances have improved in energy efficiency by 30 to 90%. Today, products that meet strict energy efficiency guidelines set by the U.S. Environmental Protection Agency and the Department of Energy earn the Energy Star label. These products have advanced technologies that use 10 to 50% less energy than standard models. Energy Star products include big appliances such as refrigerators, clothes washers, dishwashers, and air conditioners, as well as table lamps and windows.

Other improvements in technology include:

❂ Smarter thermostats that can cut heating and air-conditioning costs up to 33%. Using a microcomputer, these thermostats allow you to divide the day into periods and to program each period with a specific temperature. For example, at 6 a.m., a half hour before you get up on a cold day, the thermostat can increase the heat to a comfortable temperature. When everyone leaves the house at 8 a.m., the thermostat goes back down. Then at 5 p.m., just before people come home, the heat comes back on, until 10 p.m. when everyone goes to bed.

ENERGY EFFICIENCY

❂ Compact fluorescent light bulbs (CFLs) that can last up to 10,000 hours—10 times longer than a standard light bulb. To get the same light, the CFL needs to be just one-fourth the wattage of the standard incandescent bulb, thus using 75% less electricity. These bulbs can replace standard bulbs in table lamps, desk lamps, and ceiling or wall fixtures. They are particularly efficient in lights that will be left on for 3 to 4 hours at a time. CFLs also produce less "waste heat," thus reducing air-conditioning in warmer weather.

Entire buildings can be made more energy efficient by using these improved technologies and by installing:

❂ solar roof panels

❂ skylights

❂ light sensors that naturally reduce lighting

❂ separate climate control zones

❂ low-emission windows that allow in maximum light but minimum heat

The U.S. Green Building Council has established a system to rate the environmental and economic impact of buildings. This Leadership in Energy and Environmental Design (LEED) Green Building Rating System certifies buildings as Silver, Gold, or Platinum. The rating is based on the number of points achieved in areas such as energy efficiency, water savings, content of building materials, and indoor environmental quality. In southern California, LEED certified buildings include the Audubon Center, The Getty Center, the Los Angeles Convention Center, and Metropolitan Water District's Diamond Valley Lake Visitor Center. What other LEED certified buildings can you find?

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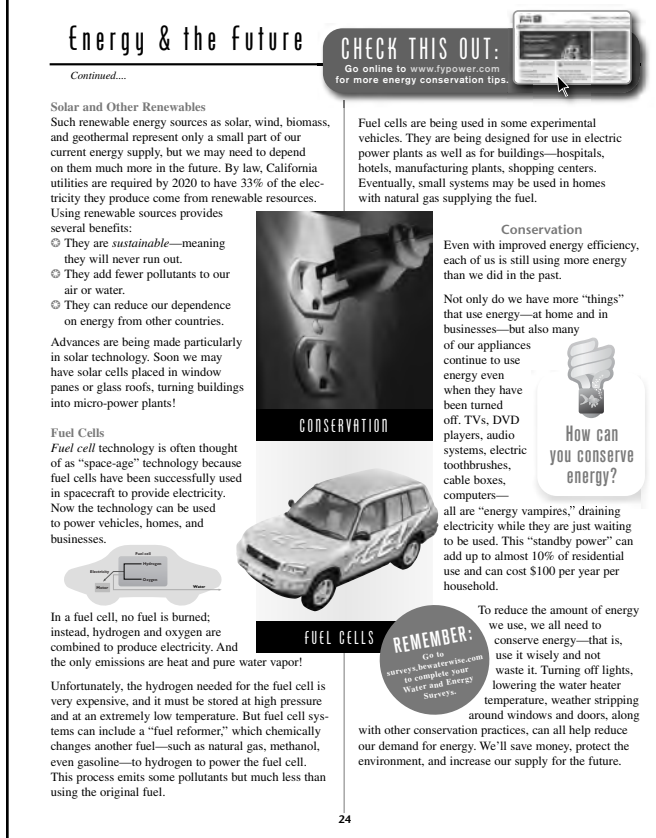

Energy & the Future

Continued....

CHECK THIS OUT:
Go online to www.fypower.com for more energy conservation tips.

Solar and Other Renewables

Such renewable energy sources as solar, wind, biomass, and geothermal represent only a small part of our current energy supply, but we may need to depend on them much more in the future. By law, California utilities are required by 2020 to have 33% of the electricity they produce come from renewable resources. Using renewable sources provides several benefits:

❂ They are *sustainable*—meaning they will never run out.

❂ They add fewer pollutants to our air or water.

❂ They can reduce our dependence on energy from other countries.

Advances are being made particularly in solar technology. Soon we may have solar cells placed in window panes or glass roofs, turning buildings into micro-power plants!

Fuel Cells

Fuel cell technology is often thought of as "space-age" technology because fuel cells have been successfully used in spacecraft to provide electricity. Now the technology can be used to power vehicles, homes, and businesses.

In a fuel cell, no fuel is burned; instead, hydrogen and oxygen are combined to produce electricity. And the only emissions are heat and pure water vapor!

Unfortunately, the hydrogen needed for the fuel cell is very expensive, and it must be stored at high pressure and at an extremely low temperature. But fuel cell systems can include a "fuel reformer," which chemically changes another fuel—such as natural gas, methanol, even gasoline—to hydrogen to power the fuel cell. This process emits some pollutants but much less than using the original fuel.

Fuel cells are being used in some experimental vehicles. They are being designed for use in electric power plants as well as for buildings—hospitals, hotels, manufacturing plants, shopping centers. Eventually, small systems may be used in homes with natural gas supplying the fuel.

CONSERVATION

Conservation

Even with improved energy efficiency, each of us is still using more energy than we did in the past.

Not only do we have more "things" that use energy—at home and in businesses—but also many of our appliances continue to use energy even when they have been turned off. TVs, DVD players, audio systems, electric toothbrushes, cable boxes, computers—all are "energy vampires," draining electricity while they are just waiting to be used. This "standby power" can add up to almost 10% of residential use and can cost $100 per year per household.

How can you conserve energy?

FUEL CELLS

REMEMBER: Go to surveys.hwaterwise.com to complete your Water and Energy Surveys.

To reduce the amount of energy we use, we all need to conserve energy—that is, use it wisely and not waste it. Turning off lights, lowering the water heater temperature, weather stripping around windows and doors, along with other conservation practices, can all help reduce our demand for energy. We'll save money, protect the environment, and increase our supply for the future.

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3. **How can a thermostat help us use less energy?**
   Some thermostats can be programmed to automatically change the setting at various times of the day. That means that the heat or the air conditioning can be programmed to go up or down or off so that the heat or AC is not accidentally left on when it isn't needed.

4. **How much less energy does a compact fluorescent light bulb use than a standard incandescent bulb?**
   A compact fluorescent light bulb uses 75% less electricity than a standard light bulb, and it can last up to 10 times longer. So even though it is more expensive to buy, it will save money over time in energy costs.

5. **What is a LEED building?**
   A LEED (Leadership in Energy and Environmental Design) building is certified to be energy and water efficient.

6. **Why don't we use more renewable energy sources now?**
   Compared to fossil fuels, renewable energy sources have been expensive, less efficient, and more difficult to use.

7. **What are the benefits of using more renewable energy sources?**
   Renewable energy sources are:
   - *sustainable, meaning they will never run out*
   - *non-polluting for our air and water*
   - *available in the United States, which means we do not have to depend on other countries for them.*

8. **How does a fuel cell work?**
   In a fuel cell, hydrogen and oxygen are combined to produce electricity; no fuel is burned.

9. **What are the advantages and disadvantages to using fuel cells?**
   An advantage to using fuel cells is that they produce no pollution; the only emissions from a fuel cell are heat and pure water vapor. The disadvantages are that hydrogen is very expensive and it is difficult to store.

10. **Why do each of us use more energy today than we did in the past?**
    Although energy efficiency of appliances has improved, we have more "things" that use energy. Also, many of our appliances have a "stand-by" mode, which continues to use energy even when the appliance is turned off.

11. **What are the benefits of conserving energy?**
    By conserving energy, which means using it wisely and not wasting it, we can:
    - *save money*
    - *put fewer pollutants into the environment*
    - *have more energy available for the future.*

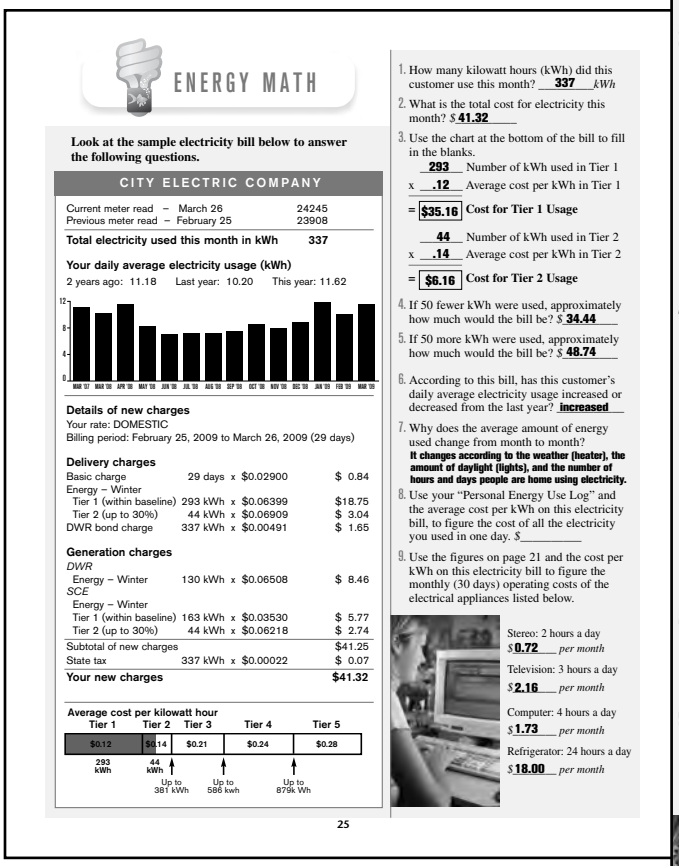
12. **How can you conserve energy?**
    Allow students to share their ideas.

C. Have students look at the back of their student booklets. Explain that this **Conservation House** depicts many ways to save energy. Ask students to point out energy conservation practices that they see. Point out the web address on the page **(www.mwdh2o.com/education/conservationhouse)** and tell students that if they go online, they can "scroll" through this energy-efficient home to see exactly how energy is being saved.

III. Solve Math Problems

A. Have students turn to page 25 in their booklets—*Energy Math.* Tell students that they are to use the sample electricity bill to answer the questions. Have students work either:
- individually
- in pairs or groups
- together as a class

B. Correct the exercise with the class, working through the problems and discussing the answers.



ENERGY MATH

Look at the sample electricity bill below to answer the following questions.

CITY ELECTRIC COMPANY

Current meter read – March 26 24245
Previous meter read – February 25 23908

Total electricity used this month in kWh 337

Your daily average electricity usage (kWh)
2 years ago: 11.18 Last year: 10.20 This year: 11.62

Details of new charges
Your rate: DOMESTIC
Billing period: February 25, 2009 to March 26, 2009 (29 days)

Delivery charges			
Basic charge	29 days x	$0.02900	$ 0.84
Energy – Winter			
Tier 1 (within baseline)	293 kWh x	$0.06399	$18.75
Tier 2 (up to 30%)	44 kWh x	$0.06909	$ 3.04
DWR bond charge	337 kWh x	$0.00491	$ 1.65
Generation charges			
DWR			
Energy – Winter	130 kWh x	$0.06508	$ 8.46
SCE			
Energy – Winter			
Tier 1 (within baseline)	163 kWh x	$0.03530	$ 5.77
Tier 2 (up to 30%)	44 kWh x	$0.06218	$ 2.74
Subtotal of new charges			$41.25
State tax	337 kWh x	$0.00022	$ 0.07
Your new charges			**$41.32**

Average cost per kilowatt hour

Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
$0.12	$0.14	$0.21	$0.24	$0.28
293 kWh	44 kWh	Up to 381 kWh	Up to 586 kwh	Up to 879k Wh

1. How many kilowatt hours (kWh) did this customer use this month? ___337___ *kWh*
2. What is the total cost for electricity this month? $ 41.32
3. Use the chart at the bottom of the bill to fill in the blanks.
   293 Number of kWh used in Tier 1
   x .12 Average cost per kWh in Tier 1
   = $35.16 **Cost for Tier 1 Usage**
   44 Number of kWh used in Tier 2
   x .14 Average cost per kWh in Tier 2
   = $6.16 **Cost for Tier 2 Usage**
4. If 50 fewer kWh were used, approximately how much would the bill be? $ 34.44
5. If 50 more kWh were used, approximately how much would the bill be? $ 48.74
6. According to this bill, has this customer's daily average electricity usage increased or decreased from the last year? increased
7. Why does the average amount of energy used change from month to month?
   It changes according to the weather (heater), the amount of daylight (lights), and the number of hours and days people are home using electricity.
8. Use your "Personal Energy Use Log" and the average cost per kWh on this electricity bill, to figure the cost of all the electricity you used in one day. $_____
9. Use the figures on page 21 and the cost per kWh on this electricity bill to figure the monthly (30 days) operating costs of the electrical appliances listed below.

Stereo: 2 hours a day
$0.72 *per month*
Television: 3 hours a day
$2.16 *per month*
Computer: 4 hours a day
$1.73 *per month*
Refrigerator: 24 hours a day
$18.00 *per month*

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✪ Extension Activities

- **Research conservation products and report on savings.** Determine an average cost for various new energy-saving products (e.g., Energy Star refrigerator, programmable thermostat, low-emission windows) and calculate how much energy is saved and how long the product will take to "pay for itself"—that is, even though a new energy-efficient product may be more expensive to buy, it costs less to operate, so how long will it take to make up the extra cost to purchase the product?

- **Demonstrate efficiency.** Gather the following materials: pots or pans of the same shape and size but of different materials (e.g., glass, steel, copper), hot plate, water, stopwatch. Heat equal amounts of the same temperature water in each pan until the water boils. Record the times and determine which material had the best heating efficiency.

1. How many kilowatt hours (kWh) did this customer use this month? ___337___ *kWh*
2. What is the total cost for electricity this month? $ 41.32
3. Use the chart at the bottom of the bill to fill in the blanks.
   293 Number of kWh used in Tier 1
   x .12 Average cost per kWh in Tier 1
   = $35.16 **Cost for Tier 1 Usage**
   44 Number of kWh used in Tier 2
   x .14 Average cost per kWh in Tier 2
   = $6.16 **Cost for Tier 2 Usage**
4. If 50 fewer kWh were used, approximately how much would the bill be? $ 34.44
5. If 50 more kWh were used, approximately how much would the bill be? $ 48.74
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$1.73 *per month*
Refrigerator: 24 hours a day
$18.00 *per month*

- **Experiment with lighting.** Gather the following materials: photographer's light meter, fluorescent and incandescent light bulbs of equal wattage, a lamp that can use either bulb. In a darkened room, turn on the incandescent light. Use the light meter to measure the amount of light given off at distances of 3 and 10 feet from the light. Record the findings. Carefully touch the bulb after it has been on for a few minutes to determine how hot it is. Follow the same procedures using the fluorescent bulb. Determine which is more efficient and why.

- **Test low-emission windows.** Gather the following materials: sheet of ordinary glass, sheet of low-emission glass, two identical boxes, two thermometers. Put a thermometer inside each box and place a sheet of glass on top of each box. Put the boxes next to each other outside in the sun. Measure and record the temperatures inside each box every 15 minutes. Expose the boxes to different conditions (e.g., sunny day, overcast day, tree-shaded) and compare the differences.

LESSON 8: HOME WATER & ENERGY SURVEY

Lesson Overview

Students will:

- analyze their *Home Water & Energy Surveys*
- review personalized recommendations for ways to save water and energy at home
- develop a home conservation plan
- monitor, evaluate, and revise their plans

Vocabulary

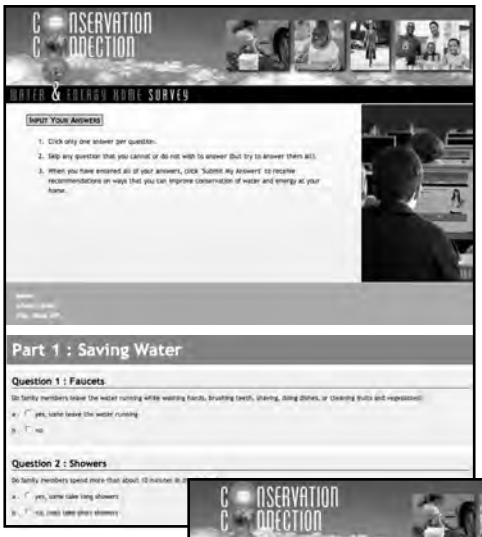
- aerator
- caulk
- hybrid
- insulation
- mulch
- weather strip

Materials and Preparation

- *Home Water & Energy Survey* completed by each student
- personalized survey results printed out for each student **(surveys.bewaterwise.com)**
- *Conservation Connection* student booklets

Approximate Time Requirement

- 1 class period to analyze survey results and make personal conservation plans
- 1 class period to evaluate home conservation plans and calculate savings



Procedures

I. Analyze Completed Home Surveys

A. Have students get out their *Home Water & Energy Survey.* Ask how they did on the survey.
   1. **Did your families get involved?**
   2. **What did your families say?**
   3. **Did you find any areas needing improvement?**

B. Be sure all students have input their survey answers online at **surveys.bewaterwise.com** and have printed out their personalized results. Explain that the results show in what areas they and their families already do well conserving water and energy and in what areas they can improve.

C. Explain that many of the recommendations for improvement relate directly to the items on the survey—for example: "wash full loads in clothes washer" and "turn down the heater thermostat." But point out that there might be other recommendations in each area—for example: "use the shortest cycle possible in the clothes washer" and "install a new programmable thermostat."

D. Take a quick tally to see which items on the survey received the most recommendations. Review suggestions for improvement for those items.

II. Visit the "Conservation House"

A. Have students once again look at the back of their booklets at the Water- and Energy-Efficient Home. Remind them that by going online to **www.mwdh2o.com/education/conservationhouse**, they can find even more recommendations for ways to conserve water and energy.

B. Encourage students to visit the Conservation House online and to note on their printouts any other conservation practices that might be useful for their families.

III. Make Personal Conservation Plans

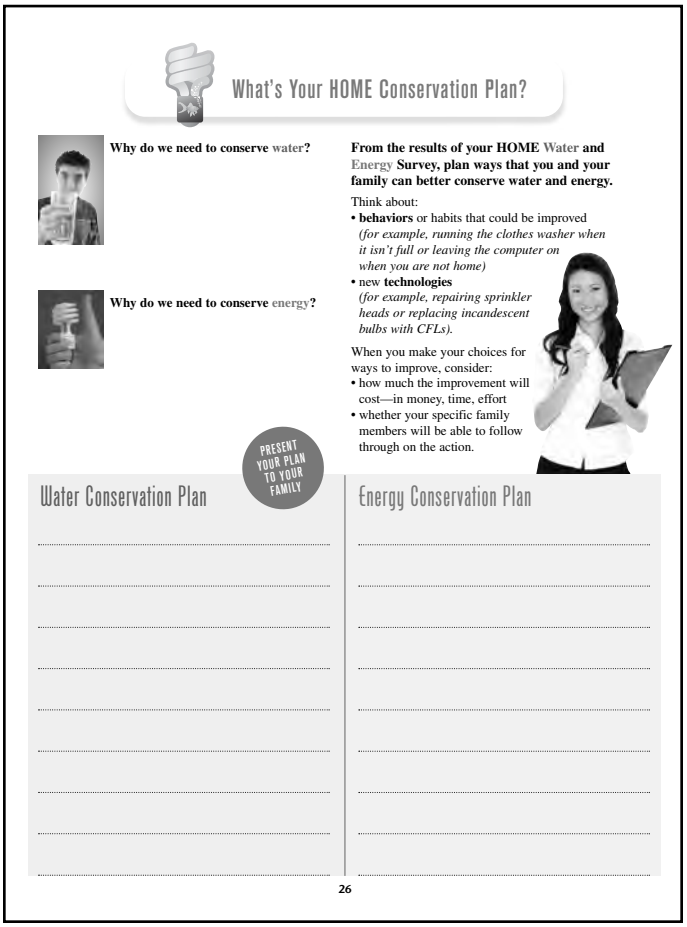
A. Have students turn to page 26 in their booklets—*What's Your Home Conservation Plan?* Ask students to fill in the answers to the questions:
   1. Why do we need to conserve water?
   2. Why do we need to conserve energy?

Discuss students' answers.

B. Tell students that from the recommendations they received from their home surveys, they are going to plan ways that they—and their families—can better conserve water and energy. Point out that many of the recommendations for conserving water and energy are simple practices and habits that anyone can do—like turning off the water while brushing teeth—while others involve more effort and expense—like changing incandescent bulbs to CFLs.

C. Ask students to look through their recommendations for **behaviors** that they can change and for **new technologies** that their families might use. Tell students to write their plans for water and energy conservation in the spaces provided.

D. Discuss some of the plans that students have made.



IV. Share Conservation Plans with Families

A. Tell students that they are to take home, share, and discuss with their families their personalized recommendations from the home survey and the plans they have made to conserve. Encourage students to talk with their families about:
- the importance of conserving water and energy
- the recommendations that indicate how their family can improve
- any changes—additions or deletions—to their plans

B. Encourage students to visit the Conservation House online with their parents **(www.mwdh2o.com/education/conservationhouse)** and to visit the sites linked to the Conservation House for even more information.

C. Set a date to discuss students' revised plans after talking with their families.

V. Evaluate Conservation Plans

A. When students bring back their Home Conservation Plans, take a tally to see what students and their families are planning to do to conserve water and energy.

B. Have students review their plans each week. Tell them to put a check by the activities that are being done and to cross off any items that have been completed (for example: fix leaky faucet). Have students update and change plans where necessary.

C. Discuss their plans periodically:
1. **Why are certain activities not being done?**
2. **What changes have been easy to make?**
3. **What changes have been difficult?**
4. **What else can you do?**

Ask students to think about what they can do to see that the conservation practices are followed. For example, if long showers are still being taken, perhaps they could put a timer in the bathroom; if the heat is still being left on at night, perhaps they could put more blankets on the beds.

VI. Retake Home Survey

A. After students have had time to implement their conservation plans with their families, have them complete the survey again.

B. Have students compare their second results with their first results. Discuss the improvements they have made in water and energy conservation.

VII. Calculate Savings in Water and Energy

A. Using the information from page 9 *(How Much Water Do You Use?)* and from page 21 *(How Much Energy Do You Use?)*, have students calculate:
   - How much water and energy their family is saving.
   - How much water and energy is being saved by the entire class.

B. Using the costs for water, electricity, and natural gas in your area (determined either from bills or by contacting utilities) have students calculate approximately how much money their families can save per month, per year.

Extension Activities

- **Organize a conservation campaign.** From their surveys, have students determine what areas most need improving. Have students plan how they can help people in their community conserve. For example, they might:
  - develop flyers to hand out
  - fix leaks
  - distribute conservation equipment, such as aerators
  - fix, unclog, or adjust sprinklers so that pavement is not being watered
  - perform draft tests on windows and caulk air leaks.
- **Design a water and energy efficient home**. Have students research and make plans to build and furnish a home that would make efficient use of water and energy.
- **Compare models**. Have students look at and compare the "Energy Guide" on appliances such as refrigerators, clothes washers, clothes dryers, and dishwashers. Why do some models use less energy or water?
- **Conduct solar experiments.** How does window size affect solar heating? What placement of windows provides the most effective solar heating of a building? How does shading windows affect the temperature inside the building? Which keeps a room coolest: drapes, window shades, blinds?
- **Demonstrate insulation.** Gather the following materials: 2 small water glasses, 2 thermometers, ice chest with ice or a refrigerator, cotton balls, small corrugated cardboard box. Fill the glasses with equal amounts of room temperature water. Measure and record the temperatures. Put cotton balls on the bottom of the cardboard box; put one glass inside; then pack the empty space between the glass and the side of the box with cotton balls. Put a thermometer in each glass and place the glasses—one in the box and one not—inside the ice-filled ice chest or refrigerator. Check and record the water temperatures after 5 minutes and 10 minutes.

LESSON 9: SCHOOL WATER & ENERGY SURVEY

IMPORTANT: *Before students survey the school, and particularly before they try to initiate changes at the school, it is important to get support from your administration. You may also need to talk with maintenance staff to inform them of students' plans and to ask for their help.*

Lesson Overview

Students will:

- conduct a survey of water and energy use at their school
- input survey results online to determine areas where conservation could be improved
- review recommendations to save water and energy at school
- develop and implement a school conservation plan
- evaluate their school plan

Materials and Preparation

- *Conservation Connection* student booklets
- *School Water & Energy Survey*
  - a copy for each student or each group printed out from **surveys.bewaterwise.com** or from the Appendix

Approximate Time Requirement

- 1-2 class periods to plan and conduct the school survey with, perhaps, some time out of class
- 1-2 class periods to analyze survey results and make conservation plan
- 10-15 minutes periodically to monitor and evaluate plan

Procedures

I. Conduct School Water & Energy Survey

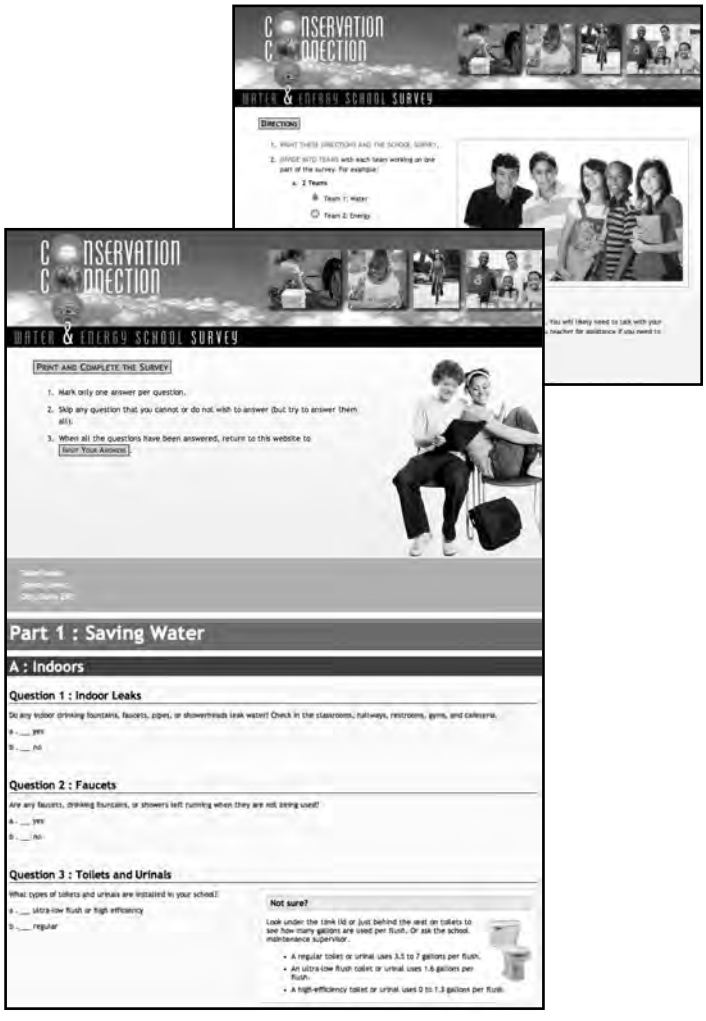
A. Tell students that besides at home, they also can make an impact on water and energy conservation at school. Show students the ***School Water & Energy Survey*** (either printed out or online at **surveys.bewaterwise.com**). Read aloud the directions for conducting the survey and point out the following:
   - Survey is divided into two parts:
     Part 1: Water
     Part 2: Energy
   - Some questions simply require observation to be answered; others require them to do a little research or to talk to maintenance people.
   - Tips for some of the items appear in boxes beside the questions.

B. Explain that once the school survey is completed, they will input their answers online to receive recommendations as to how the school can better conserve water and energy.

C. Divide the class into groups to cover the various areas on the survey:
   1. Water – Indoors *(Items 1-4)*
   2. Water – Outdoors *(Items 5-17)*
   3. Energy – Heating and Cooling *(Items 18-26)*
   4. Energy – Lights and Appliances *(Items 27-31)*
   5. Energy – Cafeteria and Waste *(Items 32-35)*
   6. Energy – Transportation *(Items 36-37)*

D. Distribute copies of the survey, or instruct students to print it out, and have the groups meet to determine what needs to be done and how they will get the answers to each question.

E. Set a date for completion.

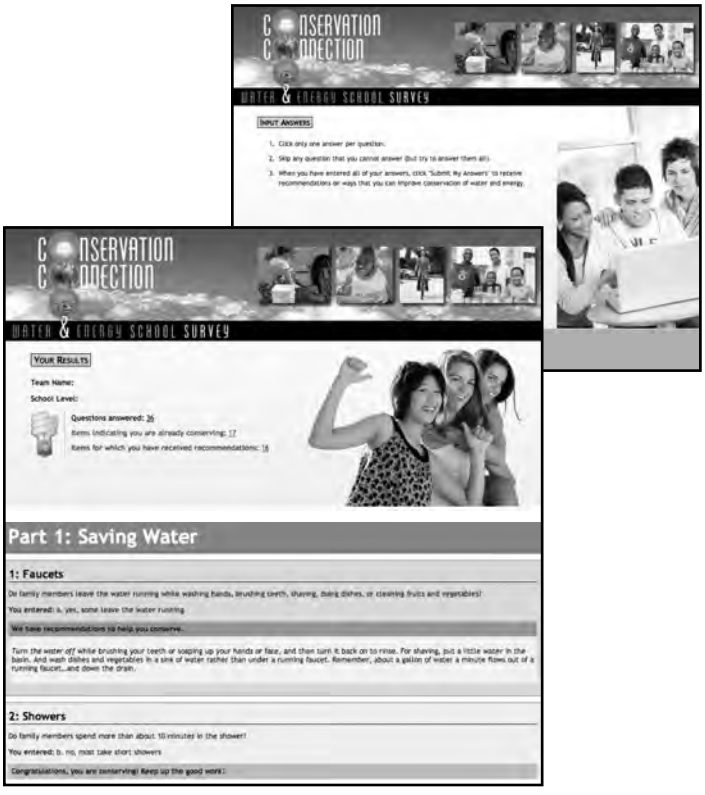


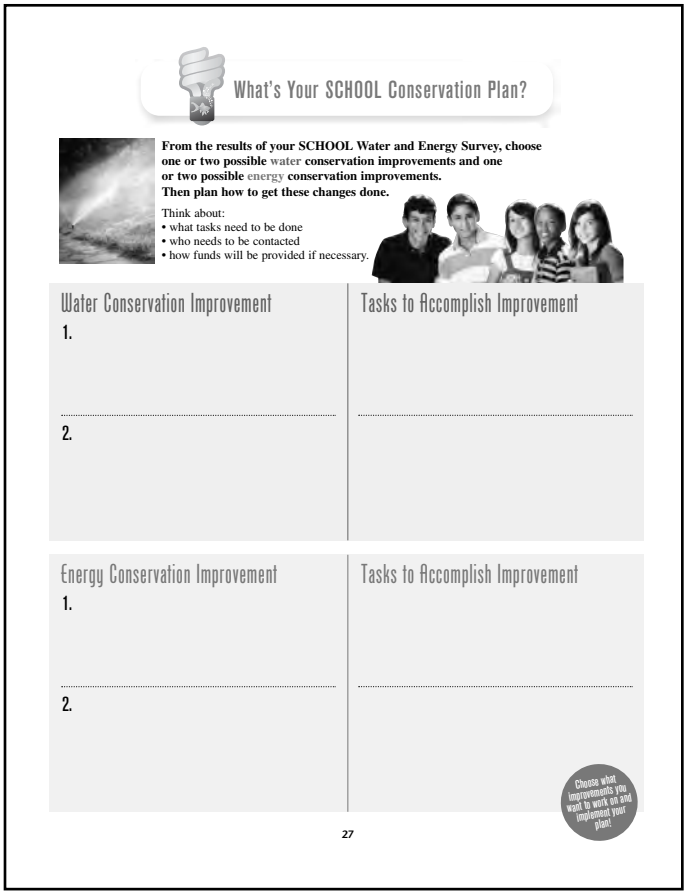
II. Input School Survey Findings

A. Have each group share the results from their section of the *School Water & Energy Survey* and discuss their findings. Ask:
   1. Were there any surprises?
   2. Did you find any areas that you think need improvement?

B. Have each group go online and follow the directions to enter their answers to the school survey. **(surveys.bewaterwise.com)**

C. Tell students that once all their answers are submitted, they will receive recommendations that indicate in what areas their school already does well conserving water and energy and how they can improve. Be sure that students print out the recommendations for their school.





III. Develop a School Water & Energy Conservation Plan

A. Have students turn to page 27 in their booklets—*What's Your School Conservation Plan?*

B. Using the recommendations printed out for their school (and any relevant conservation practices they find in the Conservation House at **www.mwdh2o.com/education/conservationhouse**), have students as a class decide what changes they would like to work on at their school. Suggest that they focus on only one or two areas (e.g., for water—leaks or overspraying sprinklers; for energy—lights on in empty rooms or equipment left on all night).

C. For the area(s) on which they've decided to focus, have students start planning how to get changes made. Either:
   - work together as a class
     or
   - divide the class into groups to plan how they would go about improving conservation in the chosen area and what tasks need to be done. Have each group share their ideas with the class and then vote on which ideas to put into action.

D. Point out to students that it is important:
   1. to find out and go through the proper "chain of command" to recommend some changes; for example, just asking the maintenance crew to do something differently will not work if the maintenance department is following a district policy.
   2. to be prepared with data, costs, specific plans, and recommendations for any presentations they make—to the principal, the school board, the maintenance supervisor.

IV. Monitor and Evaluate School Conservation Plan

A. Monitor the progress of the School Water & Energy Conservation Plan. Discuss:
   - what has and has not been accomplished
   - why certain tasks have yet to be done
   - what tasks need to be added
   - when tasks will be completed.

   Make revisions to the plan and continue to monitor the progress.

B. As a class, have students evaluate the success of the plan they made to conserve water and energy at their school. If possible, see if they can compare water or energy usage before and after their plan, either by checking bills or by checking with the district office.

Extension Activities

- **Write proposals to make improvements**. If students have found that their school needs new equipment to help conserve water or energy, have them write proposals to get the change done—both approval to make the change and money to fund the change.
- **Compare sunlight and electric light.** Cover the windows and turn on the lights necessary to work comfortably. Add up the electrical usage to keep these lights on throughout the day. Now uncover the windows and see how many lights can be turned off. Compare the usage. Also, in warm weather, compare the temperature with windows covered and uncovered and consider air conditioning load increase.
- **Examine heating and/or air conditioning systems.** Ask the school's custodian or your district's energy manager to take your students on a tour of your school's heating system and, if your school has it, air conditioning system. Have students find out how the electric and/or gas meter works, how the air gets heated or cooled, how the heated or cooled air gets into the rooms, what it costs each month to heat or cool the school.
- **Go on patrol.** Ask students to observe in the community where they see water and energy being wasted, for example, lights left on in office buildings all night, parks being watered in the rain. Keep a list and find out who to contact to change the "waster" activity.

APPENDICES

- Student Assessment
- Home Water & Energy Survey
- School Water & Energy Survey
- Service Learning Projects
- Correlations to California State Content Standards
- Correlations to the Key Education and the Environment Initiative Principles and Concepts
- Online Resources

STUDENT ASSESSMENT

Name:_____ Date:_____

Circle the letter of the answer that best completes each sentence.

1. Surface water refers to:

a. the ocean

b. water in lakes, streams, rivers, and oceans

c. water in aqueducts and reservoirs

2. Groundwater refers to:

a. all the water on top of the ground

b. all the water under the ground

c. the water in wells

3. Aqueducts are used to:

a. store water

b. prevent flooding

c. transport water

4. In the entire state of California, almost half of our water supply is used:

a. for crops and farm animals

b. in homes and businesses

c. for public services

5. In southern California, most of our water supply is used in the:

a. agricultural sector

b. environmental sector

c. urban sector

6. California's population is:

a. increasing

b. staying about the same

c. decreasing

7. In California, about 1/3 of our supply of water comes from:

a. surface water

b. groundwater

c. other states

8. In southern California, we import about:

a. 26% of our water supply

b. 66% of our water supply

c. all of our water

9. Recycled water can be used:

a. only for irrigation

b. only if fresh water is not available

c. for all purposes, even drinking in some places

10. The main reason we don't use desalination more is:

a. we don't have the technology

b. it is expensive

c. both a and b

11. We can conserve water:

a. through improved technology

b. by using non-wasteful practices

c. both a and b

STUDENT ASSESSMENT

12. In the United States, and in California, most of the energy we use comes from:

a. hydropower

b. nuclear power

c. fossil fuels

13. Fuel for biomass is:

a. wood

b. trash

c. both a and b

14. One reason that wind doesn't supply more of our energy is:

a. it's a nonrenewable source

b. wind machines are too expensive

c. it is not reliable

15. Solar cells are used to:

a. make electricity

b. heat water

c. power fuel cells

16. Geothermal energy comes from:

a. burning wood

b. heat inside the Earth

c. converting corn into fuel

17. In California, our supply of energy:

a. comes partly from other states

b. always meets our demand

c. is not a problem

18. Appliances today are generally:

a. more efficient than in the past

b. less efficient than in the past

c. bigger than those in the past

19. We can save energy in buildings by using:

a. incandescent light bulbs

b. programmable thermostats

c. more appliances with "stand-by" modes

20. Each person today uses more energy than people in the past because:

a. each appliance uses more energy

b. we have more appliances that use energy

c. both a and b

21. In the future, we may need to depend more on:

a. renewable energy sources

b. nonrenewable energy sources

c. fossil fuels

22. Conserving energy means that we will:

a. save money

b. protect the environment

c. both a and b

HOME WATER & ENERGY SURVEY

Name:_____ Date:_____

1. Mark only one answer per question, indicating the answer that is most true.
2. Skip any question that you cannot or do not wish to answer (but try to answer them all).
3. When you have marked all of your answers, go online to surveys.bewaterwise.com to input your answers and receive recommendations.

If you see this symbol, you may need the help or supervision of an adult.

PART 1: SAVING WATER

1. Faucets. Do people leave the water running while washing hands, brushing teeth, shaving, doing dishes, or cleaning fruits and vegetables?

a. yes, some people leave the water running

b. no

2. Showers. Do family members spend more than about 10 minutes in the shower?

a. yes, some take long showers

b. no, most take short showers

3. Showerheads. What is your showerhead's water output?

a. 1 to 2½ gallons per minute

b. 2½ to 5 gallons per minute

c. more than 5 gallons per minute

Not Sure?

Here's how to find out how much water your showerhead puts out:
1. Get two buckets, a watch with a second hand, and a measuring cup.
2. Hold one bucket under the showerhead and have someone turn on the water at full pressure.
3. Let the water run into the bucket for 15 seconds.
4. Measure how many cups of water are in the bucket and multiply the number of cups by 4 (to calculate how many cups per minute).
5. Convert the number of cups to gallons (16 cups in a gallon) to determine how many gallons flow per minute.
6. Go water some plants so you don't waste the water!

4. Toilet Trash. Is trash (e.g., tissues, hair, paper scraps, dental floss, etc.) sometimes flushed down toilets?

a. yes

b. no

5. Toilet Type. What type of toilet(s) do you have at home?

a. regular

b. ultra-low-flush

c. dual-flush or high-efficiency

Not Sure?

To find out what type of toilet you have, first look under the tank lid or just behind the seat. If the toilet type or gallons per flush is not indicated, here's how to find out:
1. Get a pitcher or bucket that shows measurement in cups/quarts/gallons.
2. Turn off the incoming water behind the toilet.
3. Mark the water level in the tank with tape or a grease pencil.
4. Flush the toilet.
5. Use the pitcher to refill the tank (not the bowl) to the mark you made, noting how much water is needed (16 cups = 4 quarts = 1 gallon).
6. Add ½ gallon to the total (the amount that fills the toilet bowl).
7. Now compare your figure to the numbers below to determine which type of toilet you have:
3.5 to 7 gallons per flush = regular toilet
1.6 gallons per flush = ultra low flush toilet
1.3 gallons or less per flush = dual-flush or high efficiency

7. Dishwasher and Clothes Washer. Are the dishwasher and/or clothes washer used only when full?

a. yes

b. no

c. don't have a dishwasher or clothes washer

8. Age of Appliances. Is your dishwasher or clothes washer more than 10 years old?

a. yes

b. no

c. don't have either appliance

8. Watering Time. When does the lawn or garden usually get watered?

a. morning

b. mid-day or evening

c. late night

d. don't have a lawn or garden

9. Seasonal Watering. Is the time spent watering the lawn changed depending on the season (that is, fewer minutes in fall and winter, more in spring and summer)?

a. yes

b. no

c. don't have a lawn

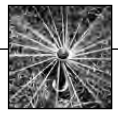
10. Sprinklers. If you use automatic sprinklers, what type are they?

a. conventional fan spray

b. rotating nozzle

c. don't have automatic sprinklers

Not Sure?



The conventional pop-up automatic sprinklers spray a fan of water across the grass. The rotating sprinkler projects streams of water while the sprinkler head rotates to cover the area.

11. Overspray. If sprinklers are used—either attached to the hose or built in—does a lot of pavement get wet from overspray?

a. yes

b. no

c. don't use sprinklers

12. Runoff. How much water runs off the lawn onto paved areas or into gutters when the lawn is watered?

a. not very much

b. quite a lot

c. don't have a lawn

13. Landscape. What makes up most of your yard?

a. mostly turf grass (lawn)

b. mostly plants

c. mostly rocks, concrete, or other elements that do not need water

d. don't have a yard

14. Plants. Are the plants in your yard mostly California Friendly®?

a. yes

b. no

c. don't know

d. don't have plants

Not Sure?

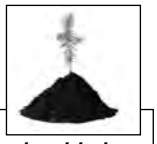
California Friendly® plants are usually native to California, don't require a lot of water, and thrive in our semi-arid climate. Go to www.bewaterwise.com for examples of these plants.

15. Mulch. Do the trees and/or plants in your yard have mulch around them?

a. yes

b. no

c. don't have trees or plants



Not Sure?

Mulch covers the soil. It might be woodchips, shredded bark, sawdust, straw, grass clippings, rubber shavings, or other organic or inorganic material.

16. Clean-ups. How often is the hose used to clean driveways, patios, sidewalks, or other pavement areas?

a. never or rarely

b. often or sometimes

17. Car Washing. Is the hose turned off while the car is being soaped before it is rinsed?

a. yes

b. no

c. don't wash car at home

18. Pool or Spa. Is the swimming pool and/or hot tub covered at night and during cool weather?

a. yes

b. no

c. don't have pool or hot tub

19. Water Leaks. Do any of your faucets, pipes, or toilets leak?

a. yes

b. no

Not Sure?

There are several ways to check for leaks. Before doing any of them, turn off all faucets and make sure no one is using any water.

- ***Find your water meter and watch the dial or the small triangular flow indicator for 5 to 10 minutes. If the meter moves, you've got a leak.***
- ***Look at all faucets and pipes, inside and outside your house: Are any dripping water? Are there any damp spots underneath them?***
- ***Put a few drops of food coloring in the tank at the back of the toilet; wait a few minutes to see if any of the color appears in the bowl. If so, you have a toilet leak.***

20. Hazardous Wastes. How does your family usually dispose of hazardous waste products?

a. take to special hazardous waste disposal sites in our community

b. put in the regular trash can or pour into gutter storm drains or down house drains

Not Sure?

Hazardous waste includes products that can harm you and the environment if they are not disposed of properly, such as:

- used motor oil	*- batteries*
- paint and paint cans	*- ink cartridges*
- cleaners and solvents	*- medicines*

Look at labels for words such as hazardous, toxic, poisonous, dangerous.

PART 2: CONSERVING ENERGY

21. Heating Temperature. At what temperature is your thermostat usually set in winter?

a. 68 degrees or lower

b. 69 degrees or higher

c. don't have a thermostat

22. Nighttime Temperature. Is the heat turned down or off at night when people go to bed?

a. yes

b. no

c. don't have a thermostat

23. Heater Vents. Are heater vents closed in unused rooms?

a. yes

b. no

c. don't have vents or unused rooms

24. Furnace Filter. Is the furnace filter changed or cleaned every month or two in winter?

a. yes

b. no

c. don't have a furnace filter

25. Cooling Temperature. At what temperature is your thermostat usually set for air conditioning?

a. 78 degrees or higher

b. 77 degrees or lower

c. don't have an air conditioner

26. Heater/Air Conditioner Tune-up. How often do you tune-up your heating/air conditioning system?

a. once a year

b. every 1 to 5 years

c. every 5 or more years

HOME WATER & ENERGY SURVEY

27. Insulation. How much insulation is in the ceiling or attic of your home?

a. 0 to 3 inches

b. 3 to 6 inches

c. 6 or more inches

d. can't tell

28. Windows and Doors. Are windows and outside doors kept closed when the heater or air conditioner is on?

a. yes

b. no, not all of the time

29. Drafts. Does air leak in or out of windows or doors even when they are closed?

a. yes

b. no

Not Sure?

To check windows and doors for leaks, make a "draftometer" and conduct the following test:

1. ***Cut a piece of thin plastic food-wrap about 5 inches wide and 10 inches long.***
2. ***Tape the short edge of the plastic along the edge of a pencil.***
3. ***Hold this draftometer near the edges of doors and windows. If the plastic moves, then air is leaking in or out.***

30. Shade. Are your windows shaded during hot weather either by trees or blinds or other window coverings?

a. yes

b. no

31. Roof Vents. Are your attic roof vents open—not covered—all year long?

a. yes

b. no

c. don't have roof vents

32. Water Heater Temperature. Is your water heater temperature set at 130 degrees or lower, or at the *conservation, medium,* or *low* settings?

a. yes

b. no

c. don't have a water heater or it is not accessible

33. Wash Temperature. What temperature is used for most loads of laundry?

a. hot

b. warm

c. cold

34. Light Bulbs. Do most of the light fixtures or lamps in your home contain fluorescent light tubes or compact fluorescent light bulbs?

a. yes

b. no

Not Sure?

Fluorescent light bulbs will likely be either long tubes or oddly shaped bulbs, both of which stay cool, as opposed to round incandescent bulbs, which get very hot.

35. Outdoor Lights. What kinds of light bulbs are used for outdoor lighting?

a. incandescent

b. fluorescent

c. high-pressure sodium

d. don't have outdoor lighting

Not Sure?

Incandescent bulbs are the typical round bulbs, which get very hot. Fluorescent bulbs are either straight tubes or tubes bent into compact bulbs, which stay cool. High-pressure sodium bulbs emit a yellowish light.

HOME WATER & ENERGY SURVEY

36. Lights and Appliances. Are lights, televisions, stereos, and other electric appliances turned off when they're not being used?

a. yes, most of the time

b. no, they are often left on

37. Cooking. Is a microwave or toaster oven, rather than the large oven in the stove, used to heat small meals or snacks?

a. yes

b. no

c. don't have a microwave or toaster oven

38. Refrigerator Coils. Are your refrigerator coils clean or dirty?

(Coils are usually located at the back of the refrigerator.)

a. clean

b. dirty or dusty

39. Ages of Major Appliances. Are any of your major appliances (such as furnace, air conditioner, water heater, refrigerator) more than 15 years old?

a. yes

b. no

40. Pool Filter. When is your pool or spa filter run?

a. during the day

b. in the evening or at night

c. don't have a pool or spa

41. Carpooling. Do you carpool to school or work on most days?

a. yes

b. no, my parent or someone else usually drives just me

c. no, I walk or bike

d. no, I take a bus or other form of mass transportation

42. Parental Taxi. Do you usually ask your parents or someone else to drive you places, even when you could walk or bike or skateboard?

a. yes

b. no

43. Shopping. Do family members sometimes shop from home via the Internet or catalogs, rather than drive to stores?

a. yes

b. no

44. Trip Links. Are several errands combined into one car trip rather than separate trips for each errand?

a. yes

b. no

45. Recycling. Are your family's old newspapers, metal cans, plastic and glass bottles, cardboard boxes, phone books, etc. recycled instead of buried in a landfill?

a. yes

b. no, most waste goes into regular trash cans and is not recycled

Not Sure?

There are several ways to recycle:

(1) Your trash company gives you separate containers for recyclable and non-recyclable waste.

(2) You put all waste in the same container because your trash company then sorts and recycles your trash.

(3) Your family saves recyclable products and takes them to a recycle center.

SCHOOL WATER & ENERGY SURVEY

Name:_____ Date:_____

1. Mark only one answer per question, indicating the answer that is most true.
2. Skip any question that you cannot or do not wish to answer (but try to answer them all).
3. When you have marked all of your answers, go online to surveys.bewaterwise.com to input your answers and receive recommendations.

PART 1: SAVING WATER

A. Indoors

1. Indoor Leaks. Do any indoor drinking fountains, faucets, pipes, or showerheads leak water? Check in the classrooms, hallways, restrooms, gyms, and cafeteria.

a. yes
b. no

2. Faucets. Are any faucets, drinking fountains, or showers left running when they are not being used?

a. yes
b. no

3. Toilets and Urinals. What types of toilets and urinals are installed in your school?

a. ultra-low flush or high efficiency
b. regular

Not Sure?

Look under the tank lid or just behind the seat on toilets to see how many gallons are used per flush. Or ask the school maintenance supervisor.

4. Showerheads. Do the showers in the locker rooms have low-flow showerheads?

a. yes
b. no
c. don't have or use showers

Not Sure?

To find out if you have low-flow showerheads, first get permission to do this test. Then:
1. Get two buckets, a watch with a second hand, and a measuring cup.
2. Hold one bucket under the showerhead and have someone turn on the water at full pressure.
3. Let the water run into the bucket for 15 seconds.
4. Measure how many cups of water are in the bucket.
5. Multiply the number of cups in the bucket by 4 to determine how many cups per minute come through your showerhead.
6. Divide the number of cups per minute by 16 to get the number of gallons per minute.
7. Go water a plant so that you don't waste the water.

If the amount is 2.5 gallons per minute or less, the showerhead is a low-flow unit.

B. Outdoors

5. Outdoor Leaks. Are there any water leaks in hoses, pipes, sprinklers, faucets, or drinking fountains outdoors?

a. yes
b. no

6. Clean-ups. How often is water from a hose used to clean walkways, paved areas, or lunch areas?

a. never
b. sometimes
c. usually or always

7. Pool Cover. Is a cover placed over the swimming pool at night and at other times when the pool is not being used?

a. yes
b. no
c. don't have a pool

8. Watering Amount. In the spring (March – June), approximately how many minutes per week are most of the sprinklers run?

a. less than 25 minutes
b. between 26 and 50 minutes
c. more than 50 minutes
d. don't have any lawn

9. Irrigation Control. Are the sprinklers run less during cooler months and not at all when it's raining?

a. yes

b. no

c. don't use sprinklers

10. Sprinkler Type. If automatic sprinklers are used, what type are they?

a. conventional fan spray

b. rotating nozzle

c. don't have automatic sprinklers

Not Sure?

The conventional pop-up automatic sprinklers spray a fan of water across the grass. The rotating sprinkler projects streams of water while the sprinkler head rotates to cover the area.

11. Sprinkler Condition. Are any of the sprinkler heads not working properly; for example, is water gushing out, trickling out, spraying poorly or unevenly, or spraying in the wrong direction?

a. yes

b. no

c. don't have automatic sprinklers

12. Overspray. Are there any areas where the sprinklers—automatic or manual— spray more onto the pavement than onto the lawn?

a. yes

b. no

c. don't use sprinklers

13. Runoff. How much water runs off the lawn either onto paved areas or down drains or gutters when the lawn is watered?

a. not very much

b. quite a lot

c. don't have a lawn

14. Landscape. What makes up most of the school's outdoor area?

a. mostly turf grass (lawn)

b. mostly plants

c. mostly rocks, concrete, or other elements that do not need water

15. Plants. Are the plants at your school mostly California Friendly®?

a. yes

b. no

c. don't know

d. don't have plants

Not Sure?

California Friendly® plants are native to California, don't require a lot of water, and thrive in our semi-arid climate. Go to www.bewaterwise.com for examples of these plants.

16. Mulch. Do the trees and/or plants have mulch around them?

a. yes

b. no

c. don't have trees or plants

Not Sure?

Mulch covers the soil. It might be woodchips, shredded bark, sawdust, straw, grass clippings, rubber shavings, or other organic or inorganic material.

17. Hazardous Wastes. How are hazardous wastes such as empty ink cartridges from printers, dead batteries, cleaning fluids, paint, and paint cans disposed of?

a. separate from other trash

b. thrown in the regular trash or poured down drains or into gutters

PART 2: CONSERVING ENERGY

C. Heating and Cooling

18. Heating and Cooling System. How old is your school's central heating and cooling system?

a. less than 15 years old

b. more than 15 years old

c. don't have a heating/cooling system

19. Heating Temperature. At what temperature are the thermostats set to heat when school is in session?

a. 68 degrees or lower

b. 69 degrees or higher

c. don't have thermostats

20. Cooling Temperature. At what temperature are thermostats set to cool when school is in session?

a. 78 degrees or higher

b. 77 degrees or lower

c. don't have an air conditioner

21. Nighttime/Weekend Temperature. Is the heating/cooling system turned off at night and on weekends when the school is empty?

a. yes

b. no

c. don't have a heating/cooling system

22. Empty Rooms. Is the heating/cooling system turned off in rooms that are not being used?

a. yes

b. no

c. don't have a heating/cooling system

23. Closing Windows and Doors. Are windows and outside doors kept closed when the heat or cooling is on?

a. yes, most of the time

b. no, sometimes they are left open

c. don't have a heating/cooling system

24. Air Leaks. Does air leak in or out of closed windows and doors?

a. yes

b. no

Not Sure?

To check windows and doors for leaks, make a "draftometer" and conduct the following test:

1. ***Cut a piece of thin plastic food-wrap about 5 inches wide and 10 inches long.***
2. ***Tape the short edge of the plastic along the edge of a pencil.***
3. ***Hold this draftometer near the edges of doors and windows. If the plastic moves, then air is leaking in or out.***
4. ***Also test electrical boxes and outlets, pipes, ducts, ceiling fixtures, attic hatches, and other locations where there is a possible air path to the outside.***

25. Blocked Vents. Are any heating or air conditioning vents blocked by furniture or other obstructions, such as stacks of books, equipment, drapes, etc.?

a. yes

b. no

c. don't have vents

26. Shade Trees. Do trees shade all or parts of the school buildings on the south and west sides?

a. yes

b. no

D. Lights and Appliances

27. Lighting Unused Rooms. Do rooms that are not being used have the lights off?

a. yes, most of the time

b. no, lights are usually left on

28. Fluorescent Lights. How old is your school's fluorescent lighting system?

a. 1 to 5 years old

b. 5 to 10 years old

c. more than 10 years old

29. Outdoor Lighting. What types of light bulbs are used in outdoor lights?

a. incandescent

b. fluorescent

c. high-pressure sodium

Not Sure?

Incandescent bulbs are the typical round bulbs, which get very hot. Fluorescent bulbs are either straight tubes or tubes bent into compact bulbs, which stay cool. High-pressure sodium bulbs emit a yellowish light.

30. Turning Things Off. Are lights and electrical equipment (e.g., TVs, radios) turned off consistently when they're not needed for more than an hour?

a. yes

b. no

31. Keeping Clean. Are light fixtures, skylights, and windows clean or dirty?

a. most are clean

b. most are dirty

E. Cafeteria and Waste

32. Exhaust Fans. Are exhaust fans (usually found above the stove or in the ceiling) run only when food is cooking?

a. yes

b. no

c. don't have exhaust fans

33. Refrigerator Coils. Are the refrigerator coils clean or dirty? (Coils are usually located on the back of the refrigerator. They dissipate the heat removed from inside the refrigerator.)

a. clean

b. dirty or dusty

c. don't have refrigerators

34. Cooking Equipment. How old is your school's cooking equipment?

a. more than 10 years old

b. less than 10 years old

c. don't have or use cooking equipment

35. Recycling. Are the metal cans, plastic and glass bottles, writing paper, and newspapers at your school recycled instead of buried in a landfill?

a. yes

b. no, our trash is not recycled

Not Sure?

There are several ways to recycle:
(1) The trash company gives your school separate containers for recyclable and non-recyclable waste.
(2) All waste is put in the same container because your trash company then sorts and recycles your trash.
(3) Your school or school district saves recyclable products and takes them to a recycle center.

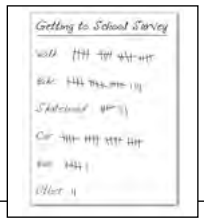
F. Transportation

36. Getting To and From School. How do <u>most</u> of the students arrive at and leave from your school?

a. walk or bike or skateboard

b. by car

c. by bus



Not Sure?

Arrive early one morning at the school entrance and tally (count) how many students arrive by walking/biking/ skateboarding, by car, and by bus.

37. Carpooling. Do most of the students who arrive and leave by car travel in carpools?

a. yes, half or more of the cars deliver more than one student to school

b. no, fewer than half of the cars deliver more than one student to school

c. very few students come and go in cars

Not Sure?

Arrive early one morning at the school entrance and tally (count) how many students arrive by car and how many of those cars contain only one student versus how many contain two or more students.

SERVICE LEARNING PROJECTS

Through service learning projects, students can apply their academic skills and knowledge to address real-life needs in their own community. At the same time, students can provide valuable services.

Service learning can:

- increase retention of specific knowledge
- provide motivation
- teach skills of civic participation
- develop an ethic of service.

Students should be actively involved in identifying community needs and planning their service project.
The steps include:

Planning – Ask specific questions, such as:

- How much time will the project take?
- What resources are needed?
- Who will we need to talk to?

Preparation – Make an action plan for the project.

- State the goal or goals for the project
- List all the tasks that need to be completed, when they need to be completed, and who will be responsible.

Implementation – Put the plan into action and keep track of progress. Review and revise the plan as needed.
Perhaps also:

- create a project scrapbook
- keep a photo log of project highlights.

Evaluation – At the completion of the project ask:

- Did the project accomplish its goal or goals?
- What was most successful?
- What would we do differently and why?
- Is more work needed?

The following projects, which help reinforce the *Conservation Connection* learning objectives, may be useful in your community.

1. Promote Recycling

If your school doesn't have a recycling program, start one! Research successful models at other schools as well as documents on "how to start a recycling program," and then use the information along with the basics below:

1. Contact local recyclers or waste haulers to gather information. Find out:
- what materials at your school can be recycled
- if recyclables can be picked up at your school
- how often materials are collected
- whether bins are provided
- how the materials must be prepared
- whether there is any payment for the materials

2. Use the gathered information to determine:
- If you need to store materials until they can be picked up or delivered, where will you store them?
- If you need to get recycling bins, where will you get them? How will you pay for them?
- If you need to deliver recyclables, how will you transport them?

3. Obtain some recycling bins, barrels, boxes, whatever, and:
- clearly label them as to what should go inside *(aluminum, glass, mixed paper, white paper, etc.)*
- anticipate problems; for example, if you think students will throw trash and food into the bins for cans, create lids with small round holes that are easy to put cans in but difficult to put anything else in.

4. Place bins in the best areas. For example:
- aluminum and glass bins in the cafeteria
- plastic and glass bins near juice machines
- paper bins in each classroom

5. Generate enthusiasm for recycling. You might:
- post signs explaining the recycling program and the "Rules for Recycling"
- have "Recycling Experts" circulating on campus for a while
- hold a school-wide assembly
- submit a recycling article to the school paper
- sponsor a poster contest to promote recycling

6. Keep up with the program. Make sure that:
- bins are emptied and that they do not become over full
- materials are being put into the right bins
- there are enough bins around campus
- recyclables are being delivered to or picked up by the recycler or hauler

7. Evaluate your program. Consider:
- Do you need more or fewer bins?
- Do you have sufficient help to properly service the program?
- Have there been any unforeseen costs?
- Do you need to put more effort into promoting the program?

2. Survey Conservation Practices at a Community Facility

Locate one or more community facilities—for example, churches, community centers, local businesses—that are willing to have their water and energy use audited. Develop a survey for that site, using the *Conservation Connection* Home Water & Energy Survey and the School Survey as examples. Once people at the site have completed the survey, analyze the results and prepare specific recommendations for conserving water and energy at that facility. Present the results and, if appropriate, help institute some of the changes.

3. Create and Conduct Community or School Presentations

Create an interesting presentation on "How to Conserve Water" or "How to Lower Your Energy Bill." Be creative and focus on practical methods that are useful to homeowners or students at schools. Be sure to explain why it is important to conserve and show how much can be saved with conservation practices. Invite members of your community to your presentation or arrange for presentations to students at your school or other schools. Perhaps have a conservation quiz and award prizes (e.g., shower timer, faucet aerator, California Friendly® plant, compact fluorescent bulb). Encourage participants to take the *Conservation Connection* Home or School Water & Energy Survey and follow the recommendations they receive to conserve more water and energy.

4. Develop and Distribute Conservation Brochures

Write, design, and produce brochures on "How to Conserve Water" and "How to Conserve Energy." Distribute the brochures at community centers, schools, local events. Or, to reduce the use of paper, obtain e-mail lists from community organizations and send the brochures electronically.

5. Distribute Conservation Devices to Homeowners

Survey your neighborhood to determine if people are using water and energy conservation devices such as faucet aerators, low-flow showerheads, hose nozzles, compact fluorescent bulbs. Check with your local water and electricity agencies for free-exchange programs. Volunteer to exchange old water- and energy-wasting devices for new conserving ones that you are able to obtain. Arrange times to deliver the devices and, perhaps, to install them if the residents desire and if you have someone with the expertise.

6. Plant California Friendly® Plants

Start at your school. Work with your maintenance staff or invite an expert, perhaps from a local nursery, to help you identify all the plants and trees on campus. Then check the bewaterwise.com website to determine if they are California Friendly varieties. If not, work with the appropriate people at your school on changing to low-water-use California Friendly plants and landscaping. On the bewaterwise.com website, in the Garden Spot, you will find beginning tips, online tutorials and classes, videos, lists of local retailers, and much more! Once your school has a California Friendly landscape, expand into the community—parks, churches, community centers, businesses.

7. Set Up Carpools

To help people find others with whom they can carpool, start a Campus Carpool. Research documents on "how to organize carpools" and use the information along with the suggestions below:

1. Write a letter announcing the carpool campaign.

- Include a response form that people can fill out if they are interested in carpooling.
- Have people fill in their names, addresses, phone numbers, the times they travel to the campus, and any restrictions they may have (number of people car can hold, days they are not available, etc.)
- Distribute the letters—by e-mail, by regular mail, and/or by sending them home with students.

2. Track responses.

- Mark on a large street map where people live and the times they travel to the school.
- Perhaps color-code for various restrictions, such as number of people in a car, available days, etc.

3. Contact possible participants.

- Invite all interested participants to a meeting, divide people into groups according to their locations and times and any other restrictions, and allow them to discuss possibilities.

  AND/OR
- Send notices to interested participants including the names and phone numbers of those people who are possible carpool companions.

4. Keep a database.

- Ask participants to keep you informed of carpools that are formed and create a database.
- Keep names and information of all participating and potential carpoolers so that carpools can continue to be arranged.

5. Expand the carpool.

- If you are successful with the Campus Carpool, or if there is more need away from school, expand to the entire community.
- Keep an online file where interested carpoolers can check for destination matches.

CORRELATIONS TO CALIFORNIA STATE CONTENT STANDARDS

		Science	Language Arts	Math
Grade 6				
Lesson	**1**	3d, 4a, 6b	**R** 1.1, 2.3. 2.4 ; **W** 1.4, 2.3	
	2	7a,e,f	**R** 1.1, 2.3, 2.4 ; **W** 1.4, 2.3	**S** 2.1, 2.5
	3		**R** 1.1, 2.3, 2.6, 2.7 ; **W** 1.4, 2.3 **LS** 1.4, 1.5, 1.6, 1.7, 2.2, 2.5	**NS** 2.3 ; **A** 1.1 ; **S** 2.1, 2.5, 3.2 **MR** 1.1, 2.3, 2.4, 2.5, 2.7
	4	7a,b,e	**R** 1.1, 2.3 ; **W** 1.4	**NS** 2.3 ; **A** 1.1, 1.4, 2.1 **S** 1.1,1.4, 3.2 **MR** 1.1, 2.4, 2.5, 2.7, 3.1
	5	3a, 4a, 6a,b,c	**R** 2.3, 2.4 ; **W** 1.4, 2.3 **LS** 1.4, 1.5, 1.6, 1.7, 2.2	
	6	7c	**R** 1.1, 2.3	**NS** 2.3 ; **A** 1.1, 1.4, 2.1 **S** 1.1 ; **MR** 1.1, 2.5, 2.7
	7	3b, 7a,b,d,e	**R** 1.1, 2.3	**NS** 2.3 ; **A** 1.1, 1.4 **MR** 1.1, 1.3, 2.5, 2.7, 3.1
	8	7a,b,d,e	**W** 1.4	**NS** 2.3 ; **A** 1.1
	9	7a,b,d,e	**W** 1.1, 1.4, 2.5 **LS** 1.4, 1.6, 1.7, 2.2, 2.4, 2.5	
Grade 7				
Lesson	**1**		**W** 1.4, 2.3	
	2		**W** 1.4, 2.3	**NS** 1.3 ; **A** 1.5
	3		**R** 2.4, 2.6 ; **W** 1.4, 2.3 **LS** 1.4, 1.5, 1.6, 2.2, 2.3	**NS** 1.2 ; **A** 1.1, 1.5 ; **MG** 1.3 **MR** 1.1, 2.5, 2.6, 2.8
	4		**R** 2.2 ; **W** 1.4	**NS** 1.2, 1.6 ; **A** 1.1, 1.5 **MG** 1.1, 1.3 **MR** 1.1, 2.5, 2.6, 2.8, 3.1
	5	4e	**R** 1.2 ; **W** 1.4, 2.3 **LS** 1.1, 1.4, 1.5, 1.6, 2.3	
	6		**R** 2.2 **NS** 1.2 ; **A** 1.5 ; **MG** 1.3	**MR** 1.1, 2.6, 2.8
	7		**R** 2.2	**NS** 1.2 ; **A** 1.5 **MR** 1.1, 1.3, 2.2, 2.6, 2.8, 3.1
	8		**R** 2.2 ; **W** 1.4	**NS** 1.2 ; **A** 1.1
	9		**R** 2.2 ; **W** 2.4 **LS** 1.4, 1.5, 1.6, 2.4	
Grade 8				
Lesson	**1**		**W** 1.4	
	2		**W** 1.4	
	3		**W** 1.4 ; **LS** 1.3, 1.6, 2.3	**AI** 5.0, 13.0 ; **PS** 1.0, 8.0
	4		**W** 1.4	**AI** 5.0, 13.0 ; **PS** 1.0, 6.0, 8.0
	5	3b	**W** 1.4, 2.3 ; **LS** 1.3, 1.6, 2.3	
	6		**R** 2.1	**AI** 5.0, 13.0 ; **PS** 6.0, 8.0
	7		**R** 2.1	**AI** 5.0, 13.0
	8		**R** 2.1 ; **W** 1.4	**AI** 5.0, 13.0
	9		**R** 2.6 ; **W** 2.4 ; **LS** 1.3, 1.6, 2.4	

Language Arts: **R**=Reading, **W**=Writing, **LS**=Listening and Speaking
Math: **NS**=Number Sense, **A**=Algebra and Functions, **S**=Statistics, Data Analysis, and Probability, **MR**=Mathematical Reasoning, **MG**=Measurement and Geometry, **AI**=Algebra I, **PS**=Probability and Statistics

CORRELATIONS TO THE KEY EDUCATION AND THE ENVIRONMENT INITIATIVE PRINCIPLES AND CONCEPTS*

	Lessons								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Principle I - ***People Depend on Natural Systems***									
Concept a. Goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.	X	X	X		X	X		X	X
Concept b. The ecosystem services provided by natural systems are essential to human life and to the functioning of our economies and cultures.	X		X						
Concept c. The quality, quantity, and reliability of goods and ecosystem services provided by natural systems are directly affected by the health of those systems.	X		X		X	X		X	X
Principle II - ***People Influence Natural Systems***									
Concept a. Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.	X		X			X			
Concept b. Methods used to extract, harvest, transport, and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems.			X		X	X			
Concept c. The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.			X		X	X			
Concept d. Legal, economic, and political systems that govern the use and management of natural systems directly influence the geographic extent, composition, biological diversity, and viability of natural systems.			X				X		
Principle III - ***Natural Systems Proceed Through Cycles***									
Concept a. Natural systems proceed through cycles and processes that are required for their functioning.	X	X							
Concept b. Human practices depend upon and benefit from the cycles and processes that operate within natural systems.		X		X	X	X			
Concept c. Human practices can alter the cycles and processes that operate within natural systems.		X				X			
Principle IV - ***Matter Is Exchanged between Natural Systems and Human Societies***									
Concept a. Effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts.		X	X	X	X	X	X	X	X
Concept b. The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect.		X		X	X	X		X	X
Concept c. The capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and the nature of its byproducts.									
Principle V - ***Decisions Affecting Resources and Natural Systems Are Complex***									
Concept a. What is the spectrum considered in making decisions about resources and natural systems and how do those factors influence decisions.			X	X	X	X	X		
Concept b. What is the process of making decisions about resources and natural systems and how has the assessment of social, economic, political, and environmental factors changed over time.				X	X		X		

** For a complete listing of the Principles and Concepts, go to www.calepa.ca.gov/education/principles/*

RESOURCES

Following are a few sites to explore for more information and other links concerning water and energy supply, demand, and conservation.

Alliance for Water Efficiency
www.allianceforwaterefficiency.org

Alliance to Save Energy
www.ase.org

American Water Works Association
www.waterwiser.org

Association of California Water Agencies
www.acwa.com
www.calwatercrisis.com

California Department of Water Resources
www.dwr.water.ca.gov

California Energy Commission
www.energy.ca.gov
www.consumerenergycenter.org

California Urban Water Conservation Council
www.cuwcc.org

Energy Information Administration
www.eia.doe.gov

Flex Your Power
www.fypower.com

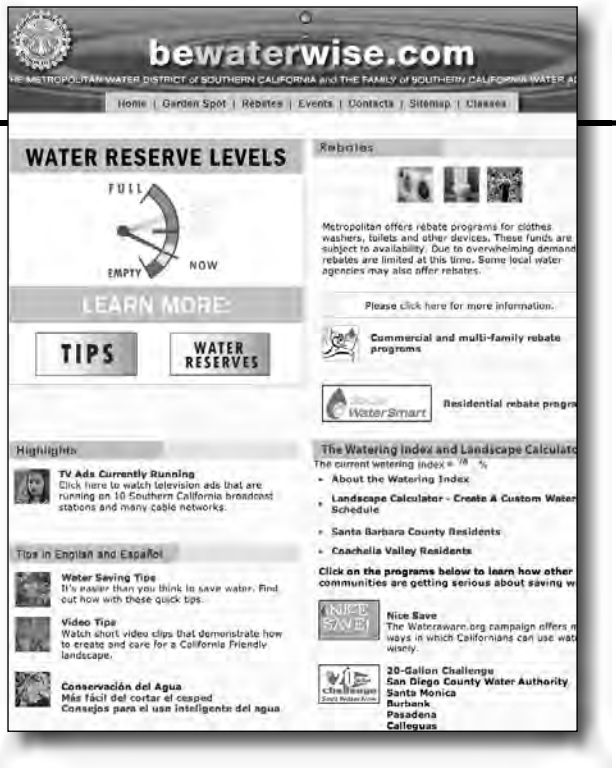
Metropolitan Water District of Southern California
www.mwdh2o.com
www.mwdh2o.com/education
www.bewaterwise.com

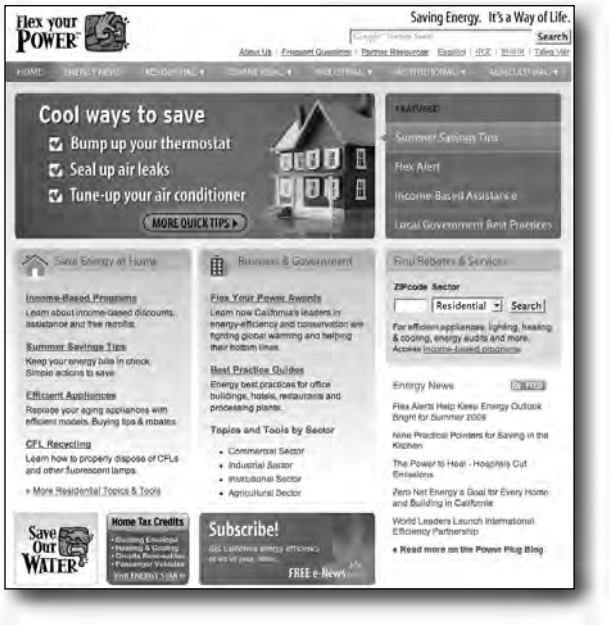
Rocky Mountain Institute
www.rmi.org

So Cal Water Smart
www.socalwatersmart.com

U.S. Environmental Protection Agency
www.energystar.gov
www.epa.gov/WaterSense

Water Education Foundation
www.watereducation.org





METROPOLITAN'S MEMBER AGENCIES

www.anaheim.net/utilities
www.beverlyhills.org
www.ci.burbank.ca.us
www.calleguas.com
Central Basin Municipal Water District
www.centralbasin.org

www.comptoncity.org
www.emwd.org
www.fmwd.com
www.ci.fullerton.ca.us

www.ci.glendale.ca.us
www.ieua.org
www.lvmwd.com
www.lbwater.org
www.ladwp.com

www.mwdoc.com
www.ci.pasadena.ca.us
www.sdcwa.org
www.ci.san-fernando.ca.us

www.ci.san-marino.ca.us
www.ci.santa-ana.ca.us
santa-monica.org
www.threevalleys.com
www.TorranceCA.Gov

www.usgvmwd.org
www.westbasin.org
www.wmwd.com

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

mwdh2o.com/education ▪ bewaterwise.com