

WATER TIMES

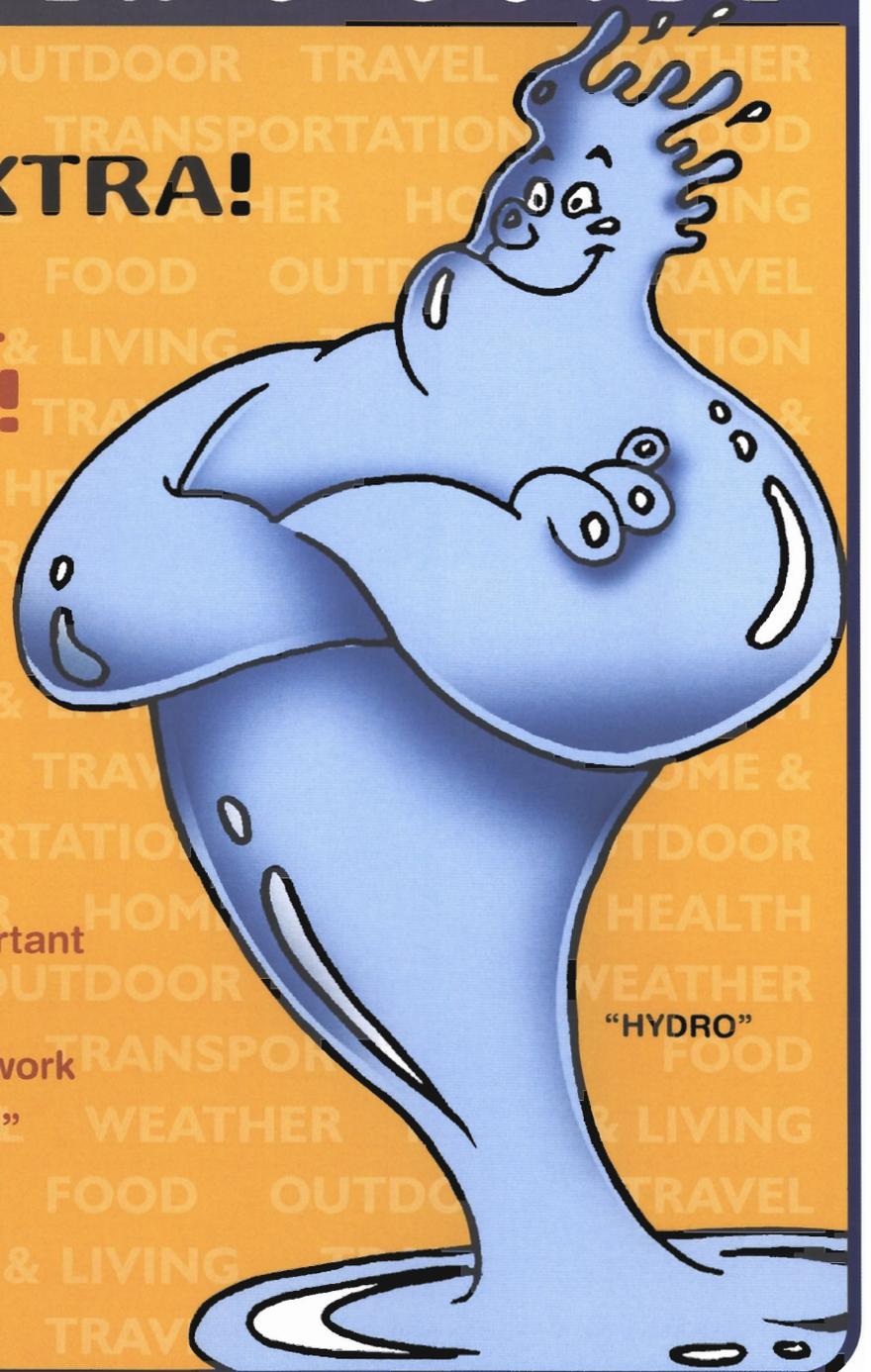
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Metropolitan Water District

A 6th Grade Educational Publication



TEACHER'S GUIDE

EXTRA! EXTRA!
READ ALL
ABOUT IT!



"HYDRO"

H
"Water is the most important
substance on earth,
H O
and everyone needs to work
together to protect it."

Acknowledgements

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Working from the vision set by the initial Teacher Advisory and the Strategic Planning Committee(s), the Curriculum Advisory Committee met regularly to expand that vision, create, provide input, and review the material at all stages of development.

Water Times was field tested by over 1,150 sixth-grade students and their teachers in 14 schools throughout Metropolitan's service area. It was revised based upon their observations, reactions, and suggestions, along with the final input from the Curriculum Committee.

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Overview of the Program

Welcome to the *Water Times*. We at the Metropolitan Water District of Southern California are pleased to provide this program to you and the sixth graders of Southern California.

We developed this program for two primary reasons: 1) to educate students about water in a manner that is supportive of the California Standards for Science, Mathematics, Social Studies, and Language Arts, and 2) to build a sense of awe about the wonders of water and promote a long-term sense of stewardship and respect.

We do not intend for you to use *Water Times* as a stand-alone, beginning-to-end curriculum unit. Rather, we hope you will find sections that you and your students will enjoy and learn from. Following that, we hope that both you and your students want to extend its use, perhaps throughout the school year.

This program is not linear, so tackling one article or section does not rely on work you have completed in the past. In addition, it is inter-curricular, weaving together lessons, critical thinking exercises, and hands-on activities that combine reading, math, science, and social studies for a broad range of learning styles and cognitive abilities.

We intend for *Water Times* to be both fun and informative. It is laced with humor and thought-provoking information. In addition, we have made it consumable so your students can take it home to read and perhaps work on with their families. It might be an ideal tool for substitutes to use with your classes on days you must be absent.

We hope that you and your students find it fun, interesting, and engaging.

Structure of the Program

1. The newspaper uses several consistent conventions to keep the information varied and interesting. **Word Roots** replace a traditional approach to vocabulary. We have tried to define all of the words in context, so with some help from you or their peers, most students should be able to figure out simple definitions. In place of a traditional vocabulary lesson, we offer information on the roots of the words. **Water Logs** are suggestions for journal entries or creative thinking exercises. Sometimes they relate directly to the story, and other times they use the information from the story as a jumping-off point for creative thought and activity. **Ask Hydro** is a tool to provide basic informational answers to questions asked by students.
2. This Teacher's Guide contains four additional stand-alone activities that complement the lessons of the newspaper. They are **Town of Joy at Risk from a Pollutant Called "Misery"** in the Health Section, **Building a Model Watershed** in the Outdoors Section, **Watching Heat Change** in the Weather Section, and **Guess That Thirst** in the Home and Living Section.

A Quick Glimpse Inside *Water Times*

p. 1 **Cover Story:**
Scientist Claims that Water Is the Most Important Thing on Earth sets the stage for the importance of water to life on earth.

p. 2 **Letter to the Editor** and **Ask Hydro** establish the fundamental importance of water to our lives and the fact that water is a precious resource that is expensive to maintain.

The letters from **Krabb E. Nut** (crabby nut) and **Schourt Cited** (short sighted) address common conceptions about water. One of Metropolitan's primary goals in producing and disseminating this program is to help students learn to respect water as a precious resource and realize the hard work that everyone must do to protect it, treat it, and move it to the tap.

Playing a Game Saves Mayan Youth from Being Turned into a Frog does not relate to any

other article or section. It tells of the importance of water from the perspective of an ancient myth from another culture.

pp. 3 – 5 **HEALTH**
Fountain of Health enables students to start thinking about the role water plays in their own health ... and thus, the importance of keeping our water supplies healthy as well.

Air-Cleaning Chemical Results in Water Pollution: The MTBE Story briefly tells the story of the discovery of MTBE in the groundwater aquifers providing water to Santa Monica. **People in the News: Miriam Cardenas, Chemist of the Week** profiles the chemist who made the discovery and acted to protect the public. The simplified chart of the **Hydrologic Cycle** shows the paths that water travels. In the case of MTBE, the chemical percolates through the ground until it mixes with groundwater.

Dr. Snow Saved London tells the story of how Dr. John Snow fathered the field of epidemiology by posing a hypothesis about how cholera travels, testing that hypothesis, then taking successful actions to save lives. Begin the lesson with **Dr. Snow Saved London**, then follow with **London in the mid-1800s** and **The Globe Theater and the Groundlings** which provide historical context for the Dr. Snow article and provide quotes from the time period. **Career Corner: Epidemiologist** describes the field that Dr. Snow created. **A Hypothetical Exercise** challenges students to state a hypothesis. **Be a Water Steward** underscores the importance of keeping our water supplies clean and free of dangerous microbes. **Dust off the director's chair** is a suggestion to students about how they can inform others about the importance of clean water. **Water Log: Are we as smart as we think we are?** frames the time period – 1850s London – a time when people were simply less informed than we are today, and it challenges students to think of possible things we might be doing today that future generations will also think of as being uninformed. **Ask Hydro: Mom's Right: Wash Your Hands** brings the conversation about germs and the spread of disease to the level at which students can take action by keeping their own hands clean.

The Dose Makes the Poison tells of the work of the 16th-century German physician, Paracelsus, who first learned the importance of the size of the dose. Even water, the article shows, can be poisonous if the dose is too high. The article introduces the important concept of “concentrations,” and **Concentrations in Real Life** make the concept relevant and real. **Stand-alone Activity: Town of Joy at Risk from a Pollutant Called “Misery”** contains background and a worksheet, which is part of this Teacher’s Guide and is ready for you to photocopy and use. It asks students to analyze risks to the community from a fictitious water pollutant, and enriches the lessons on Paracelsus and concentrations.

pp. 6 – 8

FOOD

Worth Its Weight in Water shows that most foods consist largely of water. **First Farmers Fine-Tune Focus on Food** relates agriculture and irrigation to the rise of ancient civilizations. **Put on Your Thinking Cap...** helps guide students to an understanding of how agriculture influenced civilization.

Hold the Salt: The End of Civilizations shows how some civilizations declined or disappeared when their water supplies failed and their crops could no longer sustain them. It should be followed by **Feeling Low on the Pueblo**, which provides a concrete local example of the impacts of salination on a civilization. **Water Log: Time Travel** provides an opportunity for students to try to explain the water cycle to an ancient farmer.

Making Ocean Water and Measuring Concentrations continues the lesson on

concentrations and provides a dramatic comparison of the metric system and the U.S. system of customary measures by having students calculate how to make a 35-parts-per-thousand concentration of salt water.

Help Wanted: Environmental Specialist notes the type of water professional who would work monitoring water quality and the land.

The Water Chain shows how water connects everything in our lives and on our planet.

Lettuce Tell You a Story describes the agricultural output of the Imperial Valley. **Imperial Cipherings** provides an opportunity for students to practice their math skills.

Water Log: Food Journeys is a creative thinking exercise related to agriculture and the water cycle.

pp. 9 – 11

OUTDOOR

River Moves Mountains describes the flow of the Colorado River and the deposition of river sediments near the mouth of the river in Southern California. **The Silty Salton Sink** describes the formation of the Salton Sea when a dam burst filling a sink that had been a lake periodically through history as the Colorado River changed its course, and **To Be Sea or Not to Be?** follows up on the article by challenging students to confront a complicated issue: Is the Salton Sea natural or human-made, and which of society’s resources should go toward protecting it and the water fowl that call it home? **Water Log: Changing the World** challenges students to take a more careful look at the world around them and how external forces have changed it.

The Case of the Disappearing Aqueduct describes an engineering feature of the Metropolitan Water District’s Colorado River Aqueduct: because the desert is prone to flash floods and the aqueduct is open to the elements, the aqueduct goes underground in washes where the desert soil is apt to erode.

Don’t Dis Deltas describes the importance of river deltas and introduces the Delta in Northern California at the convergence of the San Joaquin and Sacramento rivers, where much of California’s drinking water and agricultural water flows.

Nowhere and Everywhere at the Same Time asks students to analyze a line from the environmental writer Aldo Leopold describing the mouth of the Colorado River.

Draining a Watershed, See How They Run and Try This Handy Experiment illustrate the nature of watersheds. Precipitation moves downhill from wherever it lands until the water moves to the lowest point. **Think about this one for a while** stretches the information about watersheds. Regardless of the type of pollution people create, it all ultimately becomes water pollution because

pollution in the air gets washed out during storms, and pollution anywhere on earth is part of a watershed and eventually moves downward into waterways. The **Stand-alone Activity: Building a Model Watershed** enables the students to see and manipulate elements of watersheds.

The **Photo in Need of a Caption** appears to be a river with the watershed visible. It is actually a fractal that just happens to look like a river system and watershed.

pp. 12 – 13 The **California Map** is a stand-alone mapping and geography lesson.

pp. 14 – 16 **WEATHER**

Bright Warm and Boring distinguishes between “weather” and “climate”: the first is a short-term phenomenon – “It’s raining,” or “It’s hot” – and the other is a long-term trend – “Southern California tends to be warm and sunny while Seattle tends to be drizzly and cool.” It also describes a bit about Southern California’s climate. **Hatfield the Rainmaker** tells the strange but true story of a long drought in San Diego that ended in 1916 when torrential rains flooded the county at the same time that a “rainmaker” had been hired to bring relief to the citizens. **Nature’s Own Rain Recipe** explains how rain forms in the atmosphere. **Make Your Own Weather** provides directions for hands-on activities that model weather phenomena.

Amazing News About Atmospheric Water Vapor explains the remarkable role water vapor plays in moderating severe temperature swings on earth. The **Stand-alone Activity: Watching Heat Change** demonstrates the role of various kinds of thermal mass in regulating changes in heat flow.

Weather Wows!, Which of these two days will feel hotter?, and **Weather Puzzles** provide puzzles and interesting facts about weather.

pp. 17 – 20 **HOME AND LIVING**

Let Me Count the Ways leads students to reflect on their own water use ... and perhaps their own wasteful habits.

The Elixir of Life explains why water is so important to our own health and biological processes. **Ruminating with Rumi** attaches a poetic image to the notion that our bodies consist mainly of water. (Jalaludin Rumi was indeed a famous 13th-century Persian poet. His is not a fictitious or humorous name.)

Bottled or Tap? provides directions for students to be able to compare the cost of bottled water versus tap water. This section will require some preparation: the cost and bottle size of bottled water from various sources, such as supermarkets, restaurants, and convenience stores. **Wet Your Whistle** and **Water Log: What’s Up with That** lead students to think about people’s motivation for drinking tap water or bottled water.

Cleaning Up Your Act or Rub-a-Dub-Dub, How Much Water Do YOU Use in the Shower, and **Getting Practical** provide tools for students to analyze their own water use in the activity of showering, which is probably their single-biggest use of water. Assign **How Much Water Do YOU Use in the Shower** as homework, then analyze the data in class.

Ask Hydro: Morning, Noon, or Night? provides practical information about optimal times for outdoor watering.

Show Me the Money! and **How much water is needed to keep a football field green all year long** provide opportunities to practice math and understand the cost of water, the savings associated with water-conserving fixtures, and the amount of water needed to keep lawns, parks, and playgrounds green in Southern California. **Hey drip! How do I fix that drop?** and **Still more savings: Energy** describe other areas where resources and money get wasted, often unknowingly.

Ask Hydro: Putting a New Bloom on Gardening introduces students to the concept of “native” and “California friendly” plants, which are plants that thrive in the climate and natural conditions of Southern California. The **Stand-alone Activity: Guess that Thirst** leads students to observe and develop hypotheses about qualities of low-water-use (California friendly) and high-water-use plants.

pp. 21 – 23 **TRANSPORTATION**

Water on the Move traces water development to ancient times. **The Dawn of Civilization** highlights some of the changes that have accompanied people living in larger and larger groups. **Was Your Hometown Founded Near a River?** and **Test Your River Knowledge** give students an opportunity to see a relationship between old, established cities and rivers, which provide a reliable supply of fresh water.

Building the Roman Aqueducts tells the story of history’s most famous aqueduct builders, and the **Roman Engineering Strategies** shows the strategies Romans used to move water across a variety of terrains. **The Aqueduct Systems of Rome and Southern California** gives students a tool to compare and contrast the aqueducts of California with those of the Roman Empire. **Aqueduct Trivia** provides information about California’s aqueduct system.

Ancient Practice, Modern Practice and **Water Treatment** describe the basic steps of water treatment and show the students that despite a lack of scientific knowledge, the Romans inadvertently built a system that provided a reasonably high degree of water treatment.

p. 24 **Warning: Citizen’s Committee Warns of Hazards from Dihydrogen Monoxide** (p. 24) illuminates the importance of critical reading: while it is written to sound scary, the mysterious

substance is nothing more than water. This article will work best after your students are familiar with the humor and conventions of the rest of the newspaper.

WORD ROOTS

Agriculture	In Latin, “agri” means “field,” and “culture” means “to cultivate or nurture” so “agriculture” means “planting and raising a field of crops.”	Hydration	The root word “hydro” is Greek for “water.” The suffix “-ate” means “having.” To be “hydrated” means “to have water.”
Alluvial	Alluvial comes from the Latin word “alluere,” meaning “to wash against.” Alluvial fans are formations made by land that has been deposited or left by water.	Irrigation	The word “irrigation” comes from the Latin word “irrigare,” which means “to water.”
Aqueduct	In Latin, “aqua” means “water,” and “ducere” means “to lead.” An “aqueduct” leads water from one place to another.	Mesopotamia	In Greek, “mesos” means “middle” or “between,” and “potamos” means “river.” Mesopotamia – “between the two rivers” – refers to the land between the Tigris and Euphrates Rivers.
Arcade	The root of “arcade” is the word “arch.” The first definition of “arcade” is “an arched, roofed building or part of a building”; the second is “a series of arches supported by columns, piers, or pillars.”	Meteorologists	Meteorology comes from the ancient Greek words “meteoros” (high in the air) and “ology” (the study of). A meteorologist studies events that happen in the atmosphere (weather).
Delta	A delta is the place where rivers fan-out just before they empty into the sea. The Greeks coined the word “delta” because the fan-like shape reminded them of the triangular shape of the letter they called “delta,” which became our letter “D.”	Reservoir	From the Latin word meaning “to keep back,” a reservoir keeps water behind a dam and stores it for later use.
Epidemic	In Greek, “epi” means “near” or “at,” and “dem” means “people.” “Epidemic” means “near the people.” Any disease that spreads widely among people is called an epidemic.	Salination	In Latin, “sal” means salt, so “salination” refers to the process of adding salt.
Erosion	Erosion comes from the Latin verb “erodere,” meaning “to gnaw away.”	Sediment	Sediment comes from the Latin verb “sedere,” which means “to sit or settle.”
		Watershed	Watershed comes from the German word “Wasserscheide.” “Wasser” means water, and “scheide” means to divide or part.

WATER LOGS

p. 5 **Are we as smart as we think we are?**
 The people of London drank water from the Thames that had been polluted with raw sewage. What were they thinking!?!
 They simply did not know that drinking the water would be unhealthy.
 Think of things you do now that people might look back on in 150 years and wonder how you could possibly have been so uninformed.

p. 7 **Time Travel**
 Pretend you are living in an ancient civilization, and you do not know about the water cycle. Describe what you see happening to the water on the fields.

Explain your observations without mentioning the word evaporation.

Now pretend you are from the modern day and are transported back to ancient times. Explain to the people the water cycle and how it affects farming. Use whatever technique you prefer for your explanation: writing, pictures, demonstration, or something else.

p. 8 **Food Journeys**
 Describe the travels of a drop of water through the food chain.

p. 9 **Changing the World**
 What other natural forces besides water have shaped and reshaped the earth?

What are some human activities that reshape the earth? Find an example of a natural or human-made force that has altered the earth. Take, find, or draw a picture of it. Describe how it has changed the earth.

p. 10 Write a poem that uses personification to describe a body of water, such as a stream, river, delta, or watershed.

p. 11 **Pay Attention**
How many ways can you observe gravity's pull on water in nature, in cities, and in homes?

Keep track of these observations in your journal.

p. 16 **Be a drop**
Imagine a place where a water molecule might evaporate. In your mind, become that water molecule, creating a weather system that will take

you into the atmosphere and back to the ground as precipitation. Write about the journey from the water molecule's perspective, noting the wind, temperature, humidity, and scenery changes you experience.

p. 18 **What's up with that?**

Why do you think so many people drink bottled water instead of tap water?

p. 24 1. What is your emotional response to the presence of dihydrogen monoxide in our environment?

2. Do you think "dangerous" substances like dihydrogen monoxide should be regulated or banned?

3. When you see a "paid advertisement" in a newspaper, what questions does it raise?

Cover Story:

Scientist Claims that Water Is the Most Important Thing on Earth Other Experts Agree

by Special Correspondent H. Tuoh

THIS HEADLINE LEAD ARTICLE PROVIDES THREE IMPORTANT ELEMENTS:

1. It provides an overview of the primary objective of this program: helping to build a sense of respect and appreciation of water that leads to long-term stewardship of our precious natural resources.
2. It introduces the narrative style of this work: a newspaper with fun, yet substantive, articles that appeal to a broad range of learning modes and that lead students to think and act in new ways. We hope the students find the newspaper compelling enough

that they will be able to lead the direction of the class, and that over time they ask to come back to it multiple times.

3. It introduces one of the conventions we use throughout: phonetic names that carry internal meaning. The name of the "writer" of each article in the newspaper carries the meaning of the article's content. We know some of them may not be immediately apparent, but we have every confidence that your class will be able to translate all of them.

Back Page

WARNING: Citizen's Committee Warns of Hazards from Dihydrogen Monoxide

This story contains multiple lessons and should be used with the students after they are familiar with the general approach of the *Water Times* newspaper.

It is a "Paid Advertisement": a person or organization paid to have it placed, so there is no expectation of objective journalism. Instead, students should know immediately that in all likelihood it is either selling something or espousing a point of view.

This story is intended to sound scary, even though the substance – dihydrogen monoxide – is nothing more than water: H₂O. "Di" and "mono" are common prefixes meaning "two" and "one" respectively, so the students should be able to see that it is two hydrogen atoms and one oxygen atom. All of the information in the advertisement/article is accurate and correct; it is simply written to sound scary. Obviously, water is a major component of acid rain; steam causes burns; and thousands of people drown every year.

HEALTH

WELL, WELL, WELL

OVERVIEW

This unit helps students understand the role of clean water in personal and public health.

GOAL

Students will understand the role of clean water in personal and public health.

OBJECTIVES

Students will understand that:

- Contagious diseases can be spread by contaminated water.
- Some contamination is biological, and some is chemical.
- Scientists observe and measure contaminants in water in different ways.
- Planners can control water contamination by preventing it at the source.

CONCEPTS

1. People test new theories by carefully gathering and analyzing information.
2. Maps are valuable research tools.
3. Organisms need certain kinds of environments to survive and thrive.
4. The concentration of contamination in water is expressed as a proportion (rate).

Air Cleaning Chemical Results in Water Pollution

The MTBE Story

By Paul U. Shun

Since MTBE was first identified as a problematic compound almost 20 years ago, it has been in the news frequently. It provides an excellent topic for Internet research and critical problem solving for your more advanced students.

MTBE is a petroleum-based additive, so its primary proponent is the oil industry. One replacement for MTBE is methanol, which is an agricultural, corn-based product. Methanol's main proponent is the agriculture industry. Comparing these conflicting interests might help your students realize the complexities and difficulties related to legislative and public decision-making.

The illustration of *The Hydrologic Cycle* is simplified so your students can readily see the paths that water travels. In the case of MTBE, the chemical "percolates" into the ground where it mixes with ground water.

LESSON PLAN:

"Dr. Snow Saved London"

On studying the two overlay transparencies, your students will be

able to see what Dr. Snow saw. If cholera had traveled through the air, as most people expected, cases of the disease would have been spread more evenly through the city. As Dr. Snow hypothesized and as the overlays show, however, the disease cases were concentrated around the Broad Street water tank.

1. Copy Overlays #1 and #2 onto overhead transparency film.
2. Have your students read: "Dr. Snow Saved London" and "A Hypothetical Exercise."
3. Dr. Snow believed that cholera traveled in food and water (ingestion) rather than air (inhalation), and he studied the pattern of the disease outbreak to support his hypothesis. Have your students write their idea of how Dr. Snow might have stated his hypothesis about the cause of the disease.

"If people swallow contaminated food or water, they are likely to get sick with cholera."

4. Show Overlay #1, and have your students study patterns in it for a few minutes. Then ask the following questions:

1. Do you see a pattern in the outbreak of cholera cases? How would you describe that pattern?

The cases of cholera are clustered in one neighborhood.

Lay transparency #2 over #1, and ask these questions:

1. What feature might explain the outbreak of cholera in the Broad Street area?

The tank itself.

2. Do you think any of the other water tanks in the city contained water from the same source as the Broad Street tank?

In all likelihood, no other tanks in the city contained water from the same source as the Broad Street tank. If they did, their water was not as contaminated as that in the Broad Street tank.

3. Do you think the water in the Broad Street tank came from the Thames River upstream of London or downstream of London? Why?

Most probably downstream where it would have mixed with London's sewage, but it is also possible that there were cholera carriers upstream of London.

4. With the knowledge you currently have, what actions might you take to curb the spread of the 1854 cholera outbreak? **Stop using water from the Broad Street tank, and stop taking water from the Thames at the spot where that water was taken.**

Dr. Snow showed city officials his maps and explained how they supported his hypothesis. He convinced them to remove the handle from the Broad Street pump so people could no longer draw water from this dangerous source. The people grumbled about having to carry their water longer distances, but they also stopped getting sick! Dr. Snow's maps led to a discovery that caused the whole world to re-think the belief that cholera spreads through the

air! He never knew that the “poison” causing the disease was actually bacteria, but he did prove that the disease traveled in water.

Extender: Have students search for more information about Dr. Snow in the library and on the Internet.



Are we as smart as we think we are?

When we think back to times before our own, it is easy for us to chuckle at the naivete of people’s choices. “How could they think about drinking water containing raw sewage,” we might ask. The simple answer is that people in the mid-18th century did not know that germs carried disease.

Undoubtedly, we continue to do many activities that will cause future generations to marvel at our lack of knowledge. What might they learn about the use of tobacco or agents that cause cancer or heart disease? Might they be able to develop safer modes of transportation so thousands of people do not die on roadways every year? Only the future will tell, but your students might be able to make some good guesses.



• What epidemics threaten the world today?

AIDS, cancer, waterborne diseases like cholera that result from drinking untreated water.

• What other words come from the root “epi” and the root “dem”?

“Democracy” is government by the people. “Epicenter” describes locations near the center of an earthquake.



Mom’s Right: Wash Your Hands!

Have your students conduct web searches for cholera outbreaks after hurricanes and for the boil water orders in Cleveland after the 2003 blackout.

Also, have them research cholera and typhoid outbreaks in Chicago at the turn of the 20th century when heavy rains contaminated the water of the Chicago River.



The Dose Makes the Poison

By Howmutch S. Toomuch

Discussion Points

Paracelsus was both right and wrong in his belief that the source of disease comes from outside the body. He was right that some substances do indeed attack the body and cause illness; those attackers include microorganisms and chemical toxins. However, others were also right in their belief that imbalances in the body cause disease; genetic disease, metabolic disease, autoimmune diseases, and many cancers are caused by what might be considered “imbalances” in cellular function.

Concentrations in Real Life

- There are about 5,000,000,000 people on Earth. Get together with four of your friends so five of you are standing together. What is your “concentration” relative to the world’s population?
One part per billion
- The Metropolitan Water District provides water to about 18,000,000 people living in Southern California. What is the concentration of your class to the population of the region?
Between 1 and 2 parts per million

STAND-ALONE ACTIVITY (not in student material)

Town of Joy at Risk from a Pollutant Called “Misery”

This activity prompts students to analyze units of measurement related to water quality. From that analysis, they can realize that even tiny amounts of a contaminant can cause severe problems.

Copy and distribute the “Health Alert” page of this Teacher’s Guide. Have your students read it and follow the instructions.

According to the test results, the concentration of Misery in Year 1 (23 ppm)

would have become a problem had it remained at that level a second year. In the second year, however, it dropped to 6 parts per million, 4 parts per million below the danger level. In year three, the quality of the water improved greatly, to only 141 parts per billion.

The letter your students write should be honest but positive. The data show a strong trending toward improving water quality; the residents do not need to take any actions; and they can use the town’s water safely.

Your students may be confused about whether or not boiling would clean the contamination in the water. It is a confusing question that does not have a clear answer in this case. Different chemicals can be removed with different technologies. Some can be removed by high-level filtration, and others that evaporate readily can be removed by forcing air through the water in a process called air-stripping. Campers may have learned that boiling makes water safe to drink. That is only partly true. Boiling kills microorganisms and it can remove chemicals that volatilize – boil off – at temperatures lower than the boiling point of water. Boiling does not remove all dangerous substances, and we do not know from the information provided whether or not boiling has an effect on “misery.”

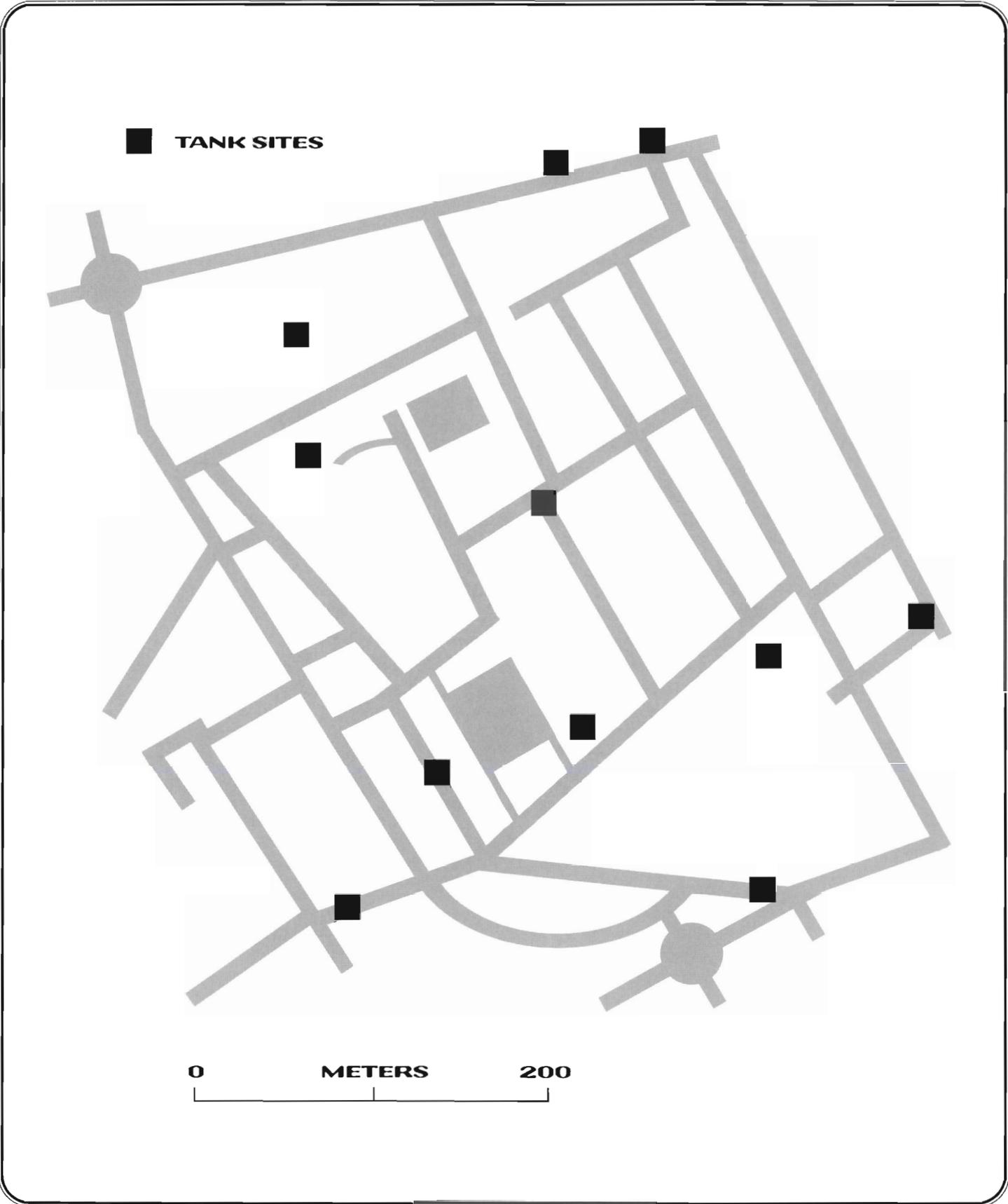
Annual Water Quality Reports

Each year in late June, every water agency in the U.S. produces a water quality report, called the CCR or Consumer Confidence Report, as required by the U.S. Safe Drinking Water Act. You can download copies of reports from the Internet or request copies from your water agency for review with your students. CCRs also provide a good tool for comparing the quality of tap water and bottled water. However, you may need to contact bottlers directly to find their test results in comparable detail. The results of water quality testing for bottled waters are sometimes not easily accessible via the web. You may also want to have your students research how their drinking water has been treated to be sure it contains no harmful microbes or chemicals. You can download the Metropolitan Water District’s annual water quality report at <http://www.mwdh20.com/waterquality>.

 **DEATHS FROM CHOLERA**



Overlay #2



HEALTH ALERT

Town of Joy at Risk from a Pollutant Called "Misery"

Over the past fifteen years, an electronics business near the Town of Joy has been disposing of a chemical called "Misery" by burying it in the ground near the lake from which the town pumps its drinking water. "Misery" has soaked into the ground and may get into the lake.

Studies have shown that "Misery" can cause the dreaded disease "miserable wretch syndrome." However, it only causes the disease when people consume it in concentrations above 10 parts per million over a period of two or more years. In smaller quantities or over less time, the water is even safe for newborn babies.

The people of Joy are worried. Their water treatment system can clean the water of microbes from birds and animals, but it cannot remove "Misery."

They want to stay informed about the concentration of "Misery" in the water. Should they drink the tap water or buy bottled water? Should they boil the water?

The Town Engineer has tested the water for three years and now has clear data about the concentration of "Misery."

Your job is to analyze the Town Engineer's information and help compose a letter to the citizens. Here is some background information on concentrations you will need:

Drinking Water Standards for Misery

< 1 mg/l	EXTREMELY SAFE
1 – 10 mg/l	SAFE
> 10 mg/l	UNSAFE
> 25 mg/l	EXTREMELY DANGEROUS

Laboratory Results Misery Testing of Water from Lake Joy

Test Period	Result
Year 1	23 ppm
Year 2	6 ppm
Year 3	141 ppb

Test results from the first three years of testing

Measurement

1 part per million = 1 milligram per liter (mg/l)

There are 1,000 milligrams in a gram, and 1,000 grams in a liter. $1,000 \times 1,000 = 1,000,000$.

1 part per billion = 1 microgram per liter ($\mu\text{g/l}$)

There are 1,000 micrograms in a milligram. $1,000 \times 1,000 \times 1,000 = 1,000,000,000$.



Write a letter to the residents of Joy explaining the results, the danger the people face, and any recommendations you may want to make. Your recommendations could include buying bottled water, receiving water from the town (paid for by taxpayers), or boiling the water.



Create a poster for the people of Joy showing the importance of keeping the water clean and free of "misery."

FOOD

WATERCRESS & WATERMELON

OVERVIEW

The goal of this unit is to develop student understanding of the essential role of water in the production of food.

GOAL

Students will understand the essential role of water in the production of food.

OBJECTIVES

Students will learn about:

- the use of water in agriculture
- problems of irrigation, such as salination

CONCEPTS

1. Without water, we would not have food to eat. When people can supplement rainfall with irrigation, they can grow more crops. With more food, a region can support more people. **Irrigation** is the act of bringing extra water to croplands so more food can grow. Advancements in civilization are often attributed to irrigated agriculture.
2. Throughout ancient history, people were attracted to places that had enough reliable water to grow ample food.
3. **Erosion and Sedimentation** are processes that create naturally fertile plains. One example is the Colorado River's role in creating the productive farmlands of California's Imperial Valley.
4. **Salination** – a build-up of salts in the soil – is an inherent problem for irrigated agriculture in hot dry climates. Although irrigation may have helped civilizations rise, it may also have helped them fall.
5. Water is an important component of food and food production.
6. The availability of water and the type of soil are two primary factors that help determine what kind of food can be grown in a region.

Put on your thinking cap and think about this...

At least five ways that agriculture helped civilizations thrive in ancient days:

Answers might include:

- Agriculture created a dependable food supply, which allowed more people to live together.
- A larger population allowed people to work at specialized jobs.
- Specialized jobs led to inventions like pottery, tool making, art, etc.

- Farming allowed people to stay in one place: their possessions didn't have to be portable so they could build more elaborate tools and buildings.
- People began to keep things; they acquired wealth and invented accounting and banking.
- Growing populations required organization, cooperation, and communication, which led to government, laws, and writing.
- People could store food; they didn't have to work all the time just to survive, so they developed recreational activities and arts.

- The early Mesopotamians invented writing, accounting, law, literature, yokes for animals, and sailboats!

All these advances resulted from growing food, which required water!



Agriculture, controlled farming, allowed early humans to begin to live together and create societies.

Hold the Salt: The End of Civilizations

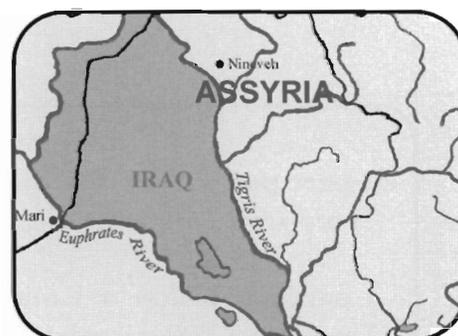
By Rew N. Thelard

"I constrained the mighty river to flow according to my will and led its water to fertilize lands that before had been barren and without inhabitants."

Queen Semiramis of Assyria, 2000 BC

Ask your students what activity they think Queen Semiramis of Assyria was referring to?

Irrigation, which allowed crops to grow on land that had been dry.



Ancient Mesopotamia and the Fertile Crescent
(Modern-day Iraq)

Note to your students the crescent shape formed by the land between the Euphrates and Tigris Rivers. That shape is why the region has come to be known as the Fertile Crescent.

Primary source for the information on irrigation: Daniel Hillel, *Rivers of Eden*



Mesopotamia, the land between the rivers, is perhaps the most well-known site of early agriculture, and it is in the heart of modern-day Iraq.

FEELING LOW ON THE PUEBLO

Salination may have also caused the downfall of some early pueblo civilizations in the American Southwest. The Hohokam and Anasazi peoples, for example, built cities in their dry lands. How were so many people able to live together in such a dry region? Irrigation. They grew corn and other crops, and they traded with people as far away as Mexico. They thrived. Then, suddenly, they disappeared.

Source: Marc Reisner, *Cadillac Desert*

Differentiation: You may want to have some of your students research causes of the decline of the pueblo civilizations, and present their findings to the class. The web contains a great deal of information. Two potential sites are:

<http://www.cliffdwelling.com/>
http://www.desertusa.com/ind1/ind_new/ind2.html

Making Ocean Water

A Hands-wet Activity
 By Sal Innidy

Using the metric system, this conversion is quite simple. Using U.S. customary units, it is rather cumbersome and complicated.

Do not be overly concerned with having your students arrive at the precise answer using U.S. customary measures, and do not let them get frustrated with the difficulty of the exercise. They should be able to visualize the metric relationship very quickly, and while some may be able to calculate the right answer using customary measures, none will be able to visualize it easily. The goal is for your students to experience the value of the metric system for working in factors of ten and to better understand why the metric system is so important to science.

Materials

- Distilled water
- A container of salt

- Metric and U.S. customary measuring instruments, including graduated cylinder
- Beaker
- Teaspoon/tablespoon
- Measuring cup divided into cups and pints

In metric, 1,000 milliliters (ml) equals one liter. So 35 ml of salt in a liter of water will equal the concentration of ocean water. To make this concentration, simply put 35 ml of salt in a metric measuring instrument, then add distilled water until the total volume equals 1,000 ml.

In U.S. customary measure, there are 16 tablespoons in a cup and 2 cups in a pint. So one tablespoon per pint, or two tablespoons per quart, will be slightly less than the salinity of ocean water (32 parts per thousand rather than 35). The arithmetic can be difficult and frustrating.

In carrying out this activity, you want your students to see the value of using the metric system because of the ease of working with factors of ten in all measures. You can either have teams of students make the concentration using both units of measure, or you can have half the class use one unit and the other half use the other unit. If you do, however, take care not to let the students using U.S. customary measures get frustrated. Their calculations and the time required to complete the activity will be greater than the groups using metric measures.

In conclusion, ask your students why they think scientists prefer using the metric system.



Irrigation allows agriculture to take place where natural rainfall or runoff does not provide enough moisture to grow crops. It was one of the first hallmarks of civilization.

THE WATER CHAIN

Kaplink, kaplink, kaplink

Concrete poetry refers to poems that have lines arranged to reflect the meaning. Have your students write a poem about water so the lines form a drop of water, such as this:

```

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Time Travel

Even without knowledge of the water cycle, farmers would readily be able to see that after a rain, the water on the leaves and in the ground miraculously disappears. It dries and goes away. Early in the mornings, though, it reappears on the leaves even when no rain fell during the night.

Farmers would benefit from knowing that water percolates into the ground and evaporates into the atmosphere. Water vapor in the atmosphere settles on leaves in the morning, a phenomenon known as "dew." Some of the water that percolates into the earth gets sucked up by the roots of the plants and provides nourishment and essential minerals.



Food Journeys

Describe the travels of a drop of water through the food chain.

Ask students to focus on these thoughts in their Water Log:

Observe

- How your food is prepared and cooked.
- Whether you can "taste" or "feel" water in different foods.
- Whether some foods made you thirsty.

Reflect

- How was water used to grow and process different foods?
- Where does water go after you eat or drink it?



Southern California imports water from other places. In what way does it also export water? (“Import” means to “bring in” and “export” means “carry to other places.”)

When California crops are shipped to other parts of the country and the world, California’s water is going with them.



Salination – a build-up of salts in the soil – is an inherent problem for irrigated agriculture in hot dry climates. Although irrigation may have helped civilizations rise, it may also have helped them fall.

Source:

Imperial County Agriculture:
http://commserv.ucdavis.edu/CEImperial/agcomrpt_02.htm

Note: These numbers are from the year 2002. They represent a good approximation, but they change from year to year. You may want to have students compare and contrast more recent numbers.

Research Extension

Have students research other primary food producing regions in California, including the Central Valley and the Sacramento-San Joaquin Delta.

Assign “compare and contrast” essays or have student teams prepare posters or oral presentations about their region. Their presentations could also explore similarities and differences to an ancient civilization they are studying this year.

Lettuce Tell You a Story

By Sal Adkrops

Imperial Ciphers

1. In 2002, the Imperial Valley had farms on almost 565,000 acres. Those fields produced sales of more than \$1,000,000,000.

On average, how many dollars did each acre of land produce?

$$\mathbf{\$1,000,000,000 / 565,000 acres = \$1,770 per acre}$$

How much would one square mile of that farmland produce?

(One square mile = 640 acres.)

$$\mathbf{640 \times \$1,770 = \$1,130,000 per square mile}$$

About how many square miles are under cultivation in the Imperial Valley?

Approximately 885

$$\mathbf{Option \#1: \$1,000,000,000 total revenue / \$1,130,000 / square mile = 885 square miles}$$

$$\mathbf{Option \#2: 565,000 acres / 640 acres per square mile = 883 square miles}$$

2. Alfalfa, cattle, and other livestock go to meat and dairy. The crops grown in the Imperial Valley are food crops. Just over half of the farm output (54%) went to meat and dairy production in 2002.

OUTDOOR

WATER ROCKS!

OVERVIEW

This section helps students understand the role water has played in shaping our physical world.

GOAL

Students will understand the role water has played in shaping our physical world.

OBJECTIVES

Students will learn that:

- Water, under the influence of gravity, causes erosion and sedimentation. It is responsible for moving mountains, carving valleys and canyons, creating fertile plains, and shaping shorelines.
- Some earthly formations are a combination of natural and human-made forces, such as the Salton Sea, which was a dry ancient lakebed recreated by a 20th-century dam burst.
- Deltas are fertile alluvial plains formed where rivers empty into the sea.
- We all live in watersheds, and watersheds are fragile systems that we must all work to protect.

CONCEPTS

1. Gravity moves water and silt through watersheds on earth.
2. Humans are powerful forces on earth.
3. Vegetation helps protect the earth from the forces of nature.

Amazing but true...

River Moves Mountains

Besides water, other natural forces that affect earth's landforms include earthquakes, volcanoes, fires, and shifting tectonic plates. Glaciers, which are water-related forces, have also had dramatic impacts on landforms. Humans have dammed rivers and changed their courses; we have also drained swamps, overused groundwater aquifers, built dikes and sea walls, cut down forests, plowed prairies, and built freeways and cities, thus changing entire ecosystems.

The signs of **erosion** and **sediment** are easy for your students to see immediately after a rain in the gullies that appear in bare hillsides and in the layer of soil that appears on the roads and sidewalks.



Changing the World

How many different forces did your class think of? Did they note more human-made or more natural forces?

TO BE SEA, OR NOT TO BE?

The issue of the future of the Salton Sea makes an excellent topic for a persuasive writing assignment or a class debate. The data is readily available and relatively easy to understand. The topic provides an opportunity for students to adopt and argue a point of view even if it is not their own.

Two particular points of interest related to the Salton Sea could be topics for student research. The first is that the Salton Sea is an important home for birds, and it is a stopover for birds migrating along the Pacific Flyway. It

provides a home to more than 400 bird species, which represents roughly half of all the species found in the U.S. The other is that the protection of the Salton Sea has become a topic of in-depth discussion among water suppliers in California. The recent 2003 "Quantification Settlement Agreement" divides California's 4.4 million acre-foot allotment of Colorado River water. That agreement offers protections to the ecosystem of the Salton Sea.

The newspapers and Internet contain stories and information about the Salton Sea. Having your students collect articles and websites about it will help them form their own opinion about whether it should be protected or left to nature.



Alluvial plains are made of the fertile sediment that washes through a watershed and down a river, then settle out when the river slows at its mouth, or delta.

Nowhere and Everywhere at the Same Time

This description by Aldo Leopold uses the literary device of personification, or anthropomorphism, imagining a natural object as a human being. Your students could do the same in their "Water Log."

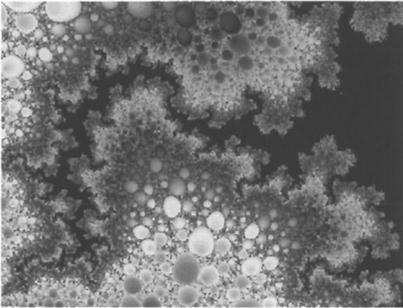
Differentiation: An advanced research activity

The Okavango Delta in Botswana is another interesting inland delta with a complex ecosystem, an unusual shape and geography, and serious environmental threats. It would be a good research and report topic for some of your students.



Delta is the widening of a river where its flow slows just before emptying into the sea. They tend to be shaped like the Greek letter Δ .

Here is a photo in need of a caption. You make up the caption for it.



This image is a "fractal." Fractals have emerged from the new field of chaos theory and mathematics, and they help to show and explain patterns in nature. This fractal appears to be a river, from its source to its delta.

Brain Stretcher:

Think about this one for a while...

All of the pollution created anywhere in the world ultimately becomes water pollution.

Imagine some type of pollution anywhere in the world, including land and air. Think of how it travels. At some point, it will always find its way to water.

Encourage your students to think critically about this notion. It will help them understand the concept of watersheds better, and it may motivate them to practice environmental stewardship throughout their lives.



Watersheds are

large, connected areas. Because of the downhill flow of water, anything that happens upstream in a watershed has an effect on the downstream section.

STAND-ALONE ACTIVITY

(not in student material)

BUILDING A MODEL WATERSHED

Materials

- Plastic or cardboard box (the top of a copier paper box works well)
- Plastic wrap, big enough to cover the box with some left over
- Newspaper
- Spray bottle with water
- Blue and red food coloring
- White paper towels

Procedure (for teams of 3-4 students)

1. Crumple three or four sheets of newspaper and place them in the box.
2. Cover the box with the plastic wrap. Push the plastic wrap down so it assumes the shape of the newspaper underneath. Leave the edges of the plastic outside the box. You can adjust the models as necessary. The activity works best if there are several low places, not just one central depression where all the rain collects.
3. Tell students that this is no longer a box of newspaper and plastic sheeting; now it is a landscape.

What are the high (and low) places called?

Hills and valleys.

What would happen if rain fell on our landscape?

Water would collect in the low places.

Would any water stay on the high places or hillsides?

Let them speculate, then try it.

4. Fill the spray bottles with water and two or three drops of blue food coloring. Have students take turns spraying water on the landscape. Each group should be supplied with paper towels to soak up spray that lands on the table. After a minute or two, ask students to stop spraying and share their observations.

NOTE: Warn students not to spray each other since food coloring, though harmless, leaves permanent stains.

Ask students:

Did the water go where you expected?

Did any water stay on the high places or hillsides?

5. Have students identify a spot at a higher elevation and predict the specific path the water will follow.
6. Have them spray again to test their prediction from step 5. They should spray gently, so gravity is the only force acting on the water.
7. Have them identify the largest pool of water forming on their model.

Will all the raindrops they spray end up in this body of water?

Which ones will and which ones won't?

Have them spray again to test their predictions.
8. Explain that the areas of land that drain to particular water bodies are called "watersheds." In nature, water flows downhill into ponds and lakes, just like in their model. Of course, nature is far more complex, with its different types of surfaces, soils and vegetation, which you can start to model in the next step.

9. Have students cover their model gently with a layer of white paper towel. They should try not to change the basic shape of their landscape by pushing down too hard, but they should try to get the towel onto the hillsides.

Ask your students to make a prediction:

How will this new feature change the way water moves in the landscape?

Have them spray again and continue to make observations.

The water moves down more slowly, and there are no longer individual drops visible where the towel covers the surface; however, they do still have ponds and lakes.

Optional:

Tell students that they can build a town in their landscape. Have them decide where to build it, where the town's

water supply should come from, and where their wastewater will go. Give them a small object to represent the town, and have them place it once they all agree.

Then tell them they have one more decision to make: where to put the town's landfill.

Prepare a small piece of paper towel with a dried drop of red food coloring. Wad this towel inside another small piece of paper towel so the coloring does not show. Once they have decided the landfill's location, place the wadded towel where they direct. (Their decision about where to place the landfill is final, so once they place the object, they cannot touch or move it.)

Now spray across the watershed one last time, paying special attention to the area around the landfill. The red coloring will begin to leach from the landfill and follow the contour of the land.

Did pollution from the landfill contaminate the drinking water?

If your students could make their decisions again about where to locate the landfill, would they do anything differently? Why?

WEATHER

WATER REIGNS!

OVERVIEW

Students will understand that the water cycle drives the Earth's climate systems and that water in the atmosphere makes Earth a livable planet.

GOAL

Students will understand that the water cycle drives the Earth's climate systems and that water in the atmosphere makes Earth a livable planet.

OBJECTIVES

Students will understand the phases of the water cycle involved in precipitation:

- radiation and convection heating
 - evaporation and evaporative cooling (perspiration)
 - condensation and the release of heat energy
 - dew point and the formation of clouds
 - heat capacity
 - relative humidity
 - air pressure
 - temperature
 - measuring devices
- Analyze data from charts, graphs, and timelines
 - Apply results of experiments to charts and graphs
 - Convert measurements from one standard to another
 - Express understanding through written, oral, and artistic forms of communication

CONCEPTS

- Weather and climate are related but not the same.
- The Pacific Ocean controls the climate of Southern California.
- Droughts have influenced human history.
- Clouds, rain, and water have inspired art and literature.
- Weather- and climate-related natural disasters occur worldwide.

WEATHER:

What you choose to wear today.

CLIMATE:

How you shop for your full wardrobe.

Discussion:

While perhaps not apparent at first, this distinction between weather and climate makes good sense. Climate is a long-term consideration, while weather is a daily phenomenon. Discuss this thought with your students, and engage them to make their own meaning from it.



Reservoirs are

human-made lakes that help supply reliable water despite periods of wet and dry. Like a savings account at a bank, reservoirs store water in wet periods so it can be used during dry periods.

Hatfield the Rainmaker

The story of Charles Hatfield and the San Diego floods is true. A web search for Charles Hatfield and San Diego floods yields numerous research references.

The Rain

1. Have your students look for other stories, poems, and artwork related to weather and climate.
2. Have your students write a story or poem about weather and climate, or have them produce a piece of "climate art." Create a classroom gallery and/or library of student-produced works.

Make Your Own Weather

Dew Point:

Your students might say that the water droplets came from inside the can. By adding a few drops of food coloring to the water inside the can, you challenge that response and compel your students to rethink their answer. In fact, the water came from the air, and there is no way for the water to escape the can. The "dew point" is the temperature at which the air can no longer hold vapor, so the water vapor condenses into droplets. To add a "control" to this experiment, fill a second can with room-temperature water but no ice.

All other things being equal, higher relative humidity means that the air is holding more water vapor than it does on days with lower humidity. The higher the relative humidity, as a rule, the higher the dew point.

Condensation:

To add a control to this demonstration, place a bag of ice over a cup of cold water. Water vapor will not condense on it, while it will condense on the bag filled with hot water because the temperature will not fall through the dew point.

Which of these two days will feel hotter?

Hot days with low humidity are not nearly as uncomfortable as hot days with high humidity.

Relative humidity is a measure of the moisture in the air. It is expressed as

a percentage of the total amount of moisture air is capable of holding at a certain temperature. So “100% relative humidity” means that the air is not able to hold any more moisture than it is holding. As a rule, 100% relative humidity means it is raining.

On all hot days, we sweat profusely. On dry days, though (days with low humidity), the sweat evaporates quickly, so we stay cooler. On humid days, we stay sweaty because the perspiration cannot evaporate back into the atmosphere.

The Temperature Really Swings on the Moon!

To convert a range of -181°C – 101°C to Fahrenheit, students will use this formula:

$$^{\circ}\text{F} = (^{\circ}\text{C} \times 1.8) + 32$$

Low range $^{\circ}\text{F} = (-181 \times 1.8) + 32$
 $^{\circ}\text{F} = -325.8 + 32$
 $^{\circ}\text{F} = -293.8^{\circ}\text{F}$
 (rounds to -300°F)

High range $^{\circ}\text{F} = (101 \times 1.8) + 32$
 $^{\circ}\text{F} = 181.8 + 32$
 $^{\circ}\text{F} = 213.8^{\circ}\text{F}$
 (rounds to 215°F)

Suggestion:

Have your students use the Internet or an almanac to find daily temperature swings in cities around the world.

What are common daily (diurnal) temperature swings in Southern California? In other parts of the U.S.? In tropical cities, such as Miami? In far northern cities, such as Chicago or Minneapolis? In cities near large bodies of water, such as Chicago or Buffalo?

In general, what role does latitude play in daily temperature?

Create charts and graphs showing the daily temperatures in the U.S. or world cities and try to find patterns.



Meteorologists are common fixtures on the television news because the weather is such an important part of everyday life.

Weather Puzzles

Source: New Scientist Magazine
<http://www.newscientist.com/lastword/results.jsp?category=Weather>

1. Why do some clouds have flat bottoms?

The flat bottom occurs at the point in the sky where the temperature is at the dew point. Below that line, the air is warm enough for the water to remain as vapor, which is invisible. Above that line, the air is cool enough for the vapor to condense, and the water becomes visible. As the vapor condenses, it releases heat, so the shape of the cloud is ever-changing.

2. Why are cloudy days cooler than sunny clear ones?

Cloud cover prevents sunlight from reaching earth, reflecting it back out into space instead.

3. Why do cloudy nights stay warmer than clear nights?

Clouds prevent heat from radiating back into space.



“Be A Drop”

Encourage your students to be as creative and innovative as they can. They will be inventing their own little water world, so they should have fun with their creation.

STAND-ALONE ACTIVITY

(not in student material)

Watching Heat Change

In this activity (Student Handout on page 18), students compare the thermal capacity, or ability to hold heat, of three materials: air, water, and soil.

Materials

- 3 coffee cups or Styrofoam® cups per student group
- Water
- Dry dirt from the yard or a garden store
- One incandescent light bulb and lamp (60-watt, 75-watt, or 100-watt) per student group

- One thermometer per student group
- One watch or clock with a second hand per student group

Lesson plan

1. Discuss experiences your students have had where they have witnessed the phenomenon of temperatures changing at different rates.

Examples:

The water in a swimming pool or lake feels colder on a hot day than a cold day. The air temperature changes much more quickly than the water temperature, so the temperature difference is smaller on a cool day, which makes the water feel warmer to the skin.

Concrete and asphalt surfaces stay warm long after the sun has set in the afternoon and the air has cooled.

2. Divide students into small groups of two to four each, and have them follow the procedure on the student worksheet.

Outcomes

The temperature will change more slowly and less dramatically in the cups containing the water and the dirt because of their high heat capacity (ability to hold heat). If you try this experiment on a very humid or rainy day and again on a very dry day, you may see a small difference in the rate of temperature change in the cup with air. You may also want to experiment with different substances, such as loosely crumbled aluminum foil, mineral oil, or rubbing alcohol.

Additional Weather Links

National Weather Resources:
 Education Resources
<http://www.nws.noaa.gov/om/edures.htm>

RANDOM WEATHER TRIVIA

<http://www.dnr.state.sc.us/climate/sercc/education/wxtrivia.html>

WEATHER SYMBOLS

http://www.dnr.state.sc.us/climate/sercc/education/wxsymbols_concentrate/pictures.html

WATCHING HEAT CHANGE

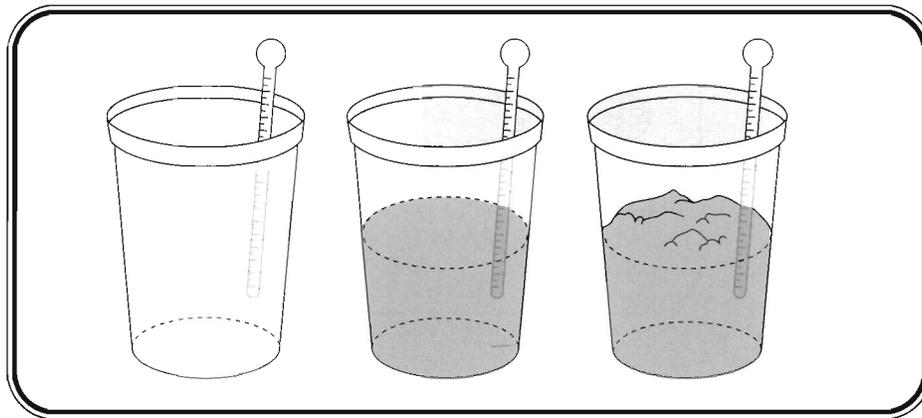
Do all substances get hot and cool at the same rate? Do they all hold heat for the same length of time? Try this little experiment to find out....

You will need

- 3 coffee cups or Styrofoam® cups
- Water
- Dry dirt from the yard or a garden store
- An incandescent light bulb (60-watt, 75-watt, or 100-watt)
- A thermometer
- A watch or clock with a second hand

Directions

1. Put an inch or so of water in one cup; put an inch or so of dry soil in another; and fill the third cup with air. (In other words, leave it empty.)
2. Heat the three cups by shining an incandescent light directly on them.
3. Measure and record the temperature inside each cup every minute for ten minutes.
4. Turn the light off, and continue recording the temperatures for another ten minutes.
5. Draw a line graph showing the different rates of change in temperature. Put elapsed time along the X axis and temperature on the Y axis. Draw each of the three lines (air, water, soil) in a different color and label them. Which cup changed temperature fastest?



Record of Temperature Readings

	Air	Dirt	Water			
Start	_____ °	_____ °	_____ °	LIGHT OFF	_____ °	_____ °
1 min	_____ °	_____ °	_____ °	11 min	_____ °	_____ °
2 min	_____ °	_____ °	_____ °	12 min	_____ °	_____ °
3 min	_____ °	_____ °	_____ °	13 min	_____ °	_____ °
4 min	_____ °	_____ °	_____ °	14 min	_____ °	_____ °
5 min	_____ °	_____ °	_____ °	15 min	_____ °	_____ °
6 min	_____ °	_____ °	_____ °	16 min	_____ °	_____ °
7 min	_____ °	_____ °	_____ °	17 min	_____ °	_____ °
8 min	_____ °	_____ °	_____ °	18 min	_____ °	_____ °
9 min	_____ °	_____ °	_____ °	19 min	_____ °	_____ °
10 min	_____ °	_____ °	_____ °	20 min	_____ °	_____ °

HOME & LIVING

CASA DE AGUA

OVERVIEW

To raise student awareness of the many ways water serves them in their daily lives, of how much water they use, and of ways to use water responsibly.

GOAL

Students will be more aware of the many ways water serves them in their daily lives, of how much water they use, and of ways to use water responsibly.

OBJECTIVES

Students will understand:

- The importance of water in daily life
- The importance of good habits and efficient fixtures to residential water conservation
- The relative cost of bottled water and tap water
- Landscaping options that can save water in Southern California

CONCEPTS

1. Efficient resource use is a matter of individual and community responsibility.
2. Not only can people preserve their quality of life while reducing resource use, but conserving limited resources also protects our quality of life.
3. Water is a renewable but limited resource.

Learning About Your Water

The water that you and your students use at home and at school comes to you from a water agency that buys some or all of its water from the Metropolitan Water District of Southern California, which produced this *Water Times* unit. (Metropolitan wholesales water to your water retailer.) Check with your school office, school maintenance personnel, or your local government to find the name of your water retailer. Visit that water agency's web site. It will contain information and maps regarding the sources of your water, the quality of your water, and tips for conserving and protecting water. You may find it to be a valuable classroom resource.



Hydration takes place every time you take a drink of water. That water sends minerals and nutrients to your cells and flushes out the waste materials. Staying well hydrated is essential to health. Perhaps your students can think of other words with the same root, such as hydrant and hydropower.

Let Me Count the Ways

This activity will work best as a group exercise. It requires both creative and critical thinking.

You should set boundaries by helping students classify their entries. For example, cooking is cooking, regardless of whether it is making juice from concentrate or steaming vegetables. There are no right or wrong answers, so reward thoughtfulness and creativity.

Challenge your students to think about ways to analyze each use and make "educated" guesses. Different households will use more or less water for particular activities. A household with a large garden or a pool will use a great deal of water outdoors, while a household with several teenagers may use more water for bathing. In general, people use a relatively small amount of water for drinking, and more than they think for doing laundry.

In addition, different students will assess the relative importance of various water uses in different ways. Your class discussion will be more important than the students' ranking. Having water to drink is essential to life and health. It should rank near the top of everyone's list.

During your class discussion, have students compare lists with their classmates. Were there uses that others did not think of but that triggered an "Oh, yeah!" response in some? Was there consensus about which activities require the most (and least) water? Was there consensus about which uses were the most or least important?



What's Up With That?

People drink bottled water for many reasons, including

1. Convenience.
2. Taste (which is a matter of personal preference).
3. Marketing. (Bottled water is touted as being healthy, but the marketers avoid saying that tap water is healthy.)

What other reasons did your students think of?

Bottled or Tap? Decisions, Decisions, Decisions!

This activity requires a small amount of planning and preparation. You or your students will need to record the prices and sizes of several samples of bottled water from several different types of stores, such as supermarkets, restaurants, and convenience markets. Either you can collect the information and use it for different classes over a period of years, or you can have your students collect the information as homework and then compile it in class.

The cost of bottled drinks

The cost of bottled drinks depends more on packaging, transportation, marketing and distribution than on the cost of the actual beverage. Aquafina® and Dasani® are made by PepsiCo® and Coca Cola® respectively. They are fundamentally the same water used in their soft drinks but without any added flavor or coloring. Challenge your students to think of

possible reasons why these bottled waters sometimes cost more than their soda pop counterparts. Make sure they touch on reasons related to supply and demand.

Comparing Costs

In our example, the bottled water costs 1,500-times more than the tap water!

CLASS ACTIVITY

Take the Water Taste Challenge

Conduct a blind taste test with your class.

Materials

- Jars filled with drinking water, one from the tap and two or three filled with different brands of bottled water
- Cups (one per student per water sample, or 3 or 4 per student total)
- Markers for marking the sample number on the cup

Procedure

1. Fill unmarked jars with samples of tap water and two or three different types of bottled waters. Keep them all at room temperature.
2. Number the jars so only you know what water is in each jar.
3. Pass empty cups to your students and have them number each cup to correspond to a bottle of water.
4. Pour a small amount of water into the cups from the bottles, and have each student taste the waters and try to describe in words the different flavors.
5. Have students rank order the waters from their favorite to their least favorite.
6. Gather the data and create a histogram of the class's rankings.
7. Discuss the flavor and price differences of your class's choices.

Did you know: Fluoride is added to some water to protect teeth?

Bottled waters do not contain fluoride, and some water agencies do not add fluoride to the water.

How Much Water Do YOU Use in the Shower?

Outliers

If one trial is very different from the other two, it is an outlier, resulting from some sort of an error in the data gathering process. Perhaps the timer read the watch wrong or the clothes washer was filling at the same time that the shower was running. Outliers are common in research, and students should know to discard the outlier and carry out another trial.

Getting Practical: Analyzing the Outcomes

This multiplication exercise demonstrates the power of making small changes and sustaining them over time. It also shows that a community working together can make a difference.

To provide a practice opportunity, you may want to have your students calculate weekly and monthly water use/savings.

In the unlikely event that everyone in your class has an efficient showerhead with a flow rate of 2.5 gallons per minute, you can have your students calculate how much water they are saving compared to the 5 gallon per minute showerheads of yesteryear.

Show Me the Money!

Eighty gallons at 1/4¢ per gallon is \$.20 per day. The showerhead will pay for itself in no more than 50 days. Fifty days is an excellent payback time. Point out to students that after the first fifty days the Smiths have "broken even" on their showerhead, and after that they are \$.20 "richer" every day because of their wise investment.

Note on units: liters versus gallons

In the section entitled "Show Me the Money," the price of water is said to be 1/4¢ per gallon. In the cost comparison between tap water and bottled water, the cost is said to be 1/10¢ per liter. Both prices, while not identical, are well within the average range of water costs. The apparent difference in price results from the shift in units, gallons versus liters, which is an important distinction for students to see.

How much water is needed to keep a football field green all year long?

1. If the field's grass needs two inches of water per week to keep it green and playable, how many inches does it need per year?
 $52 \times 2 = 104 \text{ inches per year}$
2. If 15 inches of rain falls on the field each year, how much irrigation water does it need?
 $104 - 15 = \text{about } 90 \text{ inches per year}$
3. If a football field is roughly one acre, how many acre-feet of irrigation water will it require per year?
 $90'' \div 12'' = 7.5 \text{ feet of water per year}$
 $1 \text{ acre} \times 7.5 \text{ feet} = 7.5 \text{ acre - feet}$
4. If that football field were no longer watered, how many families of four could live on the saved water?
 $7.5 \text{ acre - feet} \times 2 \text{ families/acre foot} = 15 \text{ families, or } 60 \text{ people}$

STAND-ALONE ACTIVITY

(not in student material)

Guess That Thirst

Objective

Students observe and classify characteristics of high- and low-water-consuming plants, so they can predict water consumption among plants in the future.

Materials

Your students should take responsibility for bringing plants into the classroom and identifying them as being high- or low-water-consuming. They can gather these plants by speaking to gardeners in their household or neighborhood, or they could visit a local nursery and ask for clippings.

Follow-up

After the students have completed their observations and classifications, you may want to gather a few other samples of high- and low-water-consuming plants, perhaps by asking your neighbors, your school facilities office, or a local nursery for plants or clippings. Give your students samples of plants that are different from the ones they observed and classified. Have them decide whether the plants are water-efficient or thirsty based on their earlier observations.

GUESS THAT THIRST

AN OBSERVATION AND CLASSIFICATION ACTIVITY

If you talk to any gardener, you will learn that some plants seem to be thirsty all the time, and other plants seem to do just fine with almost no water at all.

In this activity, you will observe plants that need a great deal of water and plants that need very little, and you will note some of their similarities and differences.

1. Ask one or two gardeners in your neighborhood about plants that need frequent watering and plants that do well even when they are dry for long periods. Ask for a clipping or cutting that includes a leaf, stem, and, if possible, a flower to take to school with you. If possible, learn the name of the plant. (Do not worry if you or others in your class cannot get any cuttings. Your whole class will only need a few, and you will be able to share.) Keep the plant fresh by wrapping the stem or roots in wet paper towels and placing it in a plastic bag. Be careful to keep the plants from overheating.
2. Bring the plant cuttings to school with you to observe. Make careful observations of the stems, flowers, and leaves, and try to find common characteristics.
3. To help see the network of veins in the leaf, you may want to try this technique:
 - a. Paint the back of one leaf from each plant with clear fingernail polish.
 - b. When the polish dries, put a piece of scotch tape over it, and pull it off. The tape will pull the polish off the leaf.
 - c. By studying the dried polish on the tape with a simple hand lens or magnifying glass, you will be able to observe the tiny veins and pores that make up the leaf. Draw the stems and pores from one leaf.

The veins and pores of leaves are called "stomata."

4. Complete this table.

	Plant Name (If you have it)	Water Use (high/low)	Description of the Leaves	Description of the Stem	Other Observations
1.					
2.					
3.					
4.					
5.					
6.					

ANALYZING YOUR OBSERVATIONS

1. What, if any, are the similarities you observed among the plants that use a great deal of water? Draw or list them.
2. What, if any, are the similarities you observed among the plants that use little water? Draw or list them.

TRANSPORTATION

BORN TO RUN

OVERVIEW

This unit shows how the need to move water from place to place arose in ancient civilizations with the advent of irrigated agriculture and then the development of cities.

It describes how ancient Romans met their water supply needs and relates their challenges to those of present-day Southern California.

GOAL

Students will understand how the need to move water from place to place arose in ancient civilizations with the advent of irrigated agriculture and then the development of cities.

OBJECTIVES

Students will understand:

- How ancient Romans met their water supply needs
- How the challenges faced by the ancient Romans relate to those of present-day Southern California

CONCEPTS

1. Availability of water has been a key element of cultural development.
2. Reliable water supply is crucial to community health.
3. Gravity is the central force in water delivery systems.
4. Ancient Romans developed technologies to deliver water over long distances and challenging terrain.

Test Your River Knowledge

City	River(s)
New Orleans, Louisiana	Mississippi
St. Louis, Missouri	Mississippi and Missouri
Sacramento, California	Sacramento
Washington, DC	Potomac
Paris, France	Seine
London, England	Thames
Baghdad, Iraq	Euphrates
Rome, Italy	Tiber
Cairo, Egypt	Nile
Shanghai, China	Yellow

The Aqueduct Systems of Rome and Southern California

	Rome (Y/N)	Southern California (Y/N)
Convey water by aqueducts	Y	Y
Tunnel through mountains	Y	Y
Run water through open channels	Y	Y
Convey water entirely by gravity	Y	N
Support aqueducts on arcades	Y	N
Use chemicals to disinfect the water	N	Y



Aqueduct

Can you think of other uses of the words “aqua” and “duct?”

Aquatic, aquaplane, aquamarine, aquifer, aqua culture, aquarium. Tear duct, air duct, duct tape. (Duct tape was originally designed to stop air leaks in ventilation systems.)

Suggestion:

Terrain 4: Steep narrow valleys

You may want to demonstrate siphons using clear plastic tubing or an old garden hose. You could even use the siphon to move water over desks or tables in your classroom, though the spilled water might make a bit of a mess.



While an **arcade** is generally defined as an arched structure, as in an aqueduct, your students may be more familiar with the penny arcade at an amusement park. Ask them to think about the roots of the name. We think that it might be because of the shape of the early structures, but we are not sure.

Both systems use(d) aqueducts, open channels, and tunnels through mountains. The Romans supported aqueducts on arcades and used only gravity to move water. California’s water systems use huge pumps to move water over high elevations and treat the water with chemicals such as chlorine, ammonia and ozone.

California Cartography

The mapping unit itself is an assessment tool. *(Historical chronology 3)*

California

Getting to know you, getting to know all about you

Travel Section



TEST QUESTIONS AND ANSWERS

1. You may use these questions as a tool to test learning at the conclusion of specific lessons, or you may use them to spark interest and discussion prior to starting a lesson.
2. The “Water Times” newspaper contains numerous projects and assignments. We urge you to use them as tools for authentic portfolio assessments, perhaps to be shown to parents and the school community.

HEALTH SECTION

1. In 1854, people in London were getting sick. What was the illness and what caused it? (Science, 5.0)

The illness was cholera. It was caused by people drinking water from the Thames River that had been contaminated with the cholera bacteria.

2. Explain what Paracelsus meant by the statement, “The dose makes the poison.”

Paracelsus meant that 1) anything can be safe if the dose is small enough, and 2) anything can be harmful if the dose is high enough.

FOOD SECTION

1. Why is the Imperial Valley called “America’s Salad Bowl”? (Science 2b, 2d)

It grows such large quantities of salad crops, especially lettuce, along with other vegetables, nuts, fruits, and grains.

2. If there is a drought and you live near the coast, can you water your garden with ocean water? Explain. (Science 5e)

No, because salt in the ocean water will kill your plants and ruin your soil.

OUTDOOR SECTION

1. How did the lands of the Fertile Crescent become fertile in the first place, and why did plants eventually stop thriving in that soil? (Science 2b, 2d; Historical interpretation)

They became fertile through sedimentation, as rivers flooded and deposited silt. Over a long period of time, crops began to fail, most likely from a buildup in salts after centuries of irrigation.

2. The process of water wearing away rocks and soil is called (Science 2b)
 - a. sedimentation
 - b. erosion
 - c. excavation
 - d. precipitation
3. The Grand Canyon was created (Science 2b)
 - a. by erosion
 - b. over a span of millions of years
 - c. by the Colorado River
 - d. all of the above

WEATHER SECTION

1. Why do you feel hotter on an 85° humid day than on an 85° dry day? (Science 3a)

The water vapor on a humid day holds a great deal of heat, making the temperature feel hotter and more uncomfortable. Your perspiration does not evaporate as quickly, so you lose the benefit of evaporative cooling on your skin.

2. When water evaporates, where does it go? What happens to it? (Science 6b)

It becomes water vapor in the atmosphere. Eventually that water will condense into precipitation and fall back to earth.

3. How does water help keep daily temperatures on earth more moderate than those on the moon, where there is no water? (Science 3a, 4e)

Liquid water in lakes and oceans, and water vapor in the atmosphere, absorb heat during the day and release it at night, stabilizing the earth's temperature.

4. Why are the bottoms of some clouds flat? (Science 4e)

Air temperature at the bottom of the cloud is at the dew point. Above that level, the air is cooler and water vapor condenses into cloud. Below, the air is warmer and the water remains as vapor.

HOME AND LIVING SECTION

1. Your household is trying to decide whether to buy a \$400 clothes washer that uses \$100 per year in water and energy, or a \$600 washer that uses \$50 per year in water and energy. (Math 2.0, 2.3)

A) Which washer will you buy? Why did you make the decision you made?

Students will choose. There is no right or wrong answer. The important point is that they make a choice to revisit later.

B) At the end of ten years, what will be the "lifetime" cost of each washer? Lifetime cost includes purchase price and operating cost.

The \$400 washer will have cost \$1,000 to operate (10 X \$100), so the total cost will be \$1,400.

The \$600 washer will have cost \$500 to operate (10 X \$50), so the total cost will be \$1,100.

C) Did your calculation in Part B change your answer to Part A? Why or why not?

Yes/No, depending on their answer to Part A.

2. When is the best time to water your lawn and garden?

Early in the morning. Watering late at night may cause fungus to grow, and watering in the middle of the day allows too much water to evaporate.

TRANSPORTATION SECTION

1. Early agriculture led people to start moving water from one place to another. Moving water for the purpose of growing crops is called: (World History 6.1, 6.3)

Irrigation

2. Describe at least two problems Romans faced in providing water for their city, and explain how they solved those problems. (History 6.7.8)

Problem #1: *The Tiber River didn't have enough water in the dry season, and it was polluted.*

Solution #1: *They could bring water to the city from the surrounding countryside.*

Problem #2: *The water was in the hills, far from the city.*

Solution #2: *They built aqueducts to transport the water.*

Problem #3: *There were mountains between the water sources and the city.*

Solution #3: *They built tunnels through the mountains.*

Problem #4: *If the water dropped into low valleys, there was no way to move it up to city storage reservoirs.*

Solution #4: *They built siphons to raise water from the valley floors, and they built aqueducts to keep the water flowing continuously downhill to the city.*

CALIFORNIA CONTENT STANDARD LINKS	Amazing News	Fountain of Health	Dr. Snow	Dose Makes Poison	MTBE Story	Joy & Misery	First Farmers	Hold the Salt	Lettuce Tell You a Story	Imperial Cipherings	Water Chain	Making Ocean Water	Count the Ways	Elixir of Life	Bo or
SCIENCE: FOCUS ON EARTH SCIENCE															
Plate Tectonics and Earth's Structure															
Plate tectonics accounts for important features of Earth's surface and major geologic events.															
Shaping Earth's Surface															
Topography is reshaped by the weathering of rock and soil and by the transportation and deposition of sediment.							✓			✓					
Heat (Thermal Energy) (Physical Science)															
Heat moves in a predictable flow from warmer objects to cooler objects until all the objects are at the same temperature.	✓														
Energy in the Earth System															
Many phenomena on Earth's surface are affected by the transfer of energy through radiation and convection currents.	✓														
Ecology (Life Science)															
Organisms in ecosystems exchange energy and nutrients among themselves and with the environment.		✓	✓	✓	✓	✓		✓	✓						
Resources															
Sources of energy and materials differ in amounts, distribution, usefulness, and the time required for their formation.	✓				✓	✓					✓			✓	
Investigation and Experimentation															
Scientific progress is made by asking meaningful questions and conducting careful investigations.			✓			✓		✓				✓			
MATH															
Number Sense															
Students compare and order positive and negative fractions, decimals, and mixed numbers. Students solve problems involving fractions, ratios, proportions, and percentages.				✓						✓					
Students calculate and solve problems involving addition, subtraction, multiplication, and division.									✓			✓			
Algebra and Functions															
Students write verbal expressions and sentences as algebraic expressions and equations; they evaluate algebraic expressions, solve simple linear equations, and graph and interpret their results.															
Students analyze and use tables, graphs, and rules to solve problems involving rates and proportions.									✓			✓			
Measurement and Geometry															
Statistics, Data Analysis, and Probability															
Students compute and analyze statistical measurements for data sets.				✓		✓									
Students use data samples of a population and describe the characteristics and limitations of the samples.			✓			✓									
Students determine theoretical and experimental probabilities and use these to make predictions about events.			✓	✓	✓	✓									
Mathematical Reasoning															
Students make decisions about how to approach problems.															
Students use strategies, skills, and concepts in finding solutions.			✓												
Students move beyond a particular problem by generalizing to other situations.			✓			✓									

Sub	Show Me the Money	Native Plants	Guess that Thirst	On the Move	Over the Hill	Water Treatment	Bright, Warm, Boring	Harfield	Rain Recipe	Activity Temp (tchr)	Meso Amer Mystery	Weather Puzzles	Weather Wows	Dihydrogen Monoxide	Extra! Extra!	CA Cartography	River Moves Mtns.	Silty Salton Sink	Don't Diss Deltas	Draining a Watershed
																✓	✓			
					✓	✓					✓				✓	✓	✓	✓	✓	✓
							✓		✓											
							✓	✓	✓	✓	✓	✓	✓		✓					
		✓																		
			✓			✓			✓	✓				✓		✓		✓		
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	✓																			
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	✓					✓														

CALIFORNIA CONTENT STANDARD LINKS	Amazing News	Fountain of Health	Dr. Snow	Dose Makes Poison	MTBE Story	Joy & Misery	First Farmers	Hold the Salt	Lettuce Tell You a Story	Imperial Cipherings	Water Chain	Making Ocean Water	Count the Ways	Elixir of Life	Bo or
LANGUAGE ARTS: READING															
Reading Comprehension (Focus on Informational Materials)			✓	✓											
Students read and understand grade-level appropriate material. They describe and connect the essential ideas, arguments, and perspectives of the text by using their knowledge of text structure, organization, and purpose.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Structural Features of Informational Materials Comprehension and Analysis of Grade-Level Appropriate Text															
Expository Critique															
Literary Response and Analysis			✓												
Narrative Analysis of Grade-Level Appropriate Text															
Identify and analyze features of themes conveyed through characters, actions, and images.											✓				
Explain the effects of common literary devices (e.g., symbolism, imagery, metaphor,) in a variety of fictional and nonfictional texts.											✓				
Organization and Focus															
Choose the form of writing (e.g., personal letter, letter to the editor, review, poem, report, narrative) that best suits the intended purpose.						✓				✓	✓				
Create multiple-paragraph expository compositions.											✓				
Use a variety of effective and coherent organizational patterns, including comparison and contrast, organization by categories, and arrangement by spatial order, order of importance, or climactic order.											✓				
Research and Technology															
Write persuasive compositions.						✓									
Organization and Delivery of Oral Communication															
Analysis and Evaluation of Oral and Media Communications						✓									
Deliver informative presentation						✓									
SOCIAL STUDIES															
Chronological and Spatial Thinking															
Students explain how major events are related to one another in time.		✓	✓				✓	✓							
Historical Interpretation															
Students understand and distinguish cause, effect, sequence, and correlation in historical events, including the long- and short-term causal relations.		✓	✓				✓	✓							
World History and Geography: Ancient Civilizations															
Students describe what is known through archaeological studies of the early physical and cultural development of humankind from the Paleolithic era to the agricultural revolution.								✓							
Students analyze the geographic, political, economic, religious and social structures of the early civilizations of Mesopotamia, Egypt, and Kush.							✓	✓							
Locate and describe the major river system and discuss the physical setting that supported the rise of this civilization.							✓	✓							
Students analyze the geographic, political, economic, religious and social structures during the development of Rome.															
Discuss the legacies of Roman art and architecture, technology and science, literature, language, and law.															

id	Show Me the Money	Native Plants	Guess that Thirst	On the Move	Over the Hill	Water Treatment	Bright, Warm, Boring	Harfield	Rain Recipe	Activity Temp (tchr)	Meso Amer Mystery	Weather Puzzles	Weather Wows	Dihydrogen Monoxide	Extra! Extra!	CA Cartography	River Moves Mtns.	Silty Salton Sink	Don't Diss Deltas	Draining a Watershed
							✓	✓			✓			✓	✓	✓				
	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
									✓					✓	✓					
														✓	✓	✓				
	✓													✓	✓	✓				
								✓			✓									
																			✓	
														✓						
				✓	✓						✓				✓					
				✓	✓						✓									
				✓	✓						✓									
				✓	✓	✓														
				✓	✓	✓														

A Little About the Water and Times of The Metropolitan Water District

The Metropolitan Water District of Southern California is a public agency established in 1928 to build an aqueduct bringing water from the Colorado River. Today, it is one of the nation's largest suppliers of treated drinking water, providing about half the water used by 18 million people.

Metropolitan is governed by a 37-member board of directors representing 26 cities and water agencies in a six-county service area that encompasses 5,200 square miles in Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties.

Metropolitan draws water supplies from two sources – the Colorado River Aqueduct, which it owns and operates, and the State Water Project. The Colorado River Aqueduct moves water from the east, 242 miles across the desert and mountains. The State Water Project brings water supplies from northern California through the Sacramento-San Joaquin Delta, 444 miles across the central part of the state, over the Tehachapi Mountains and into the Southern California coastal plain.

Metropolitan maintains and operates a regional distribution system that includes hundreds of miles of pipeline, five filtration plants, nine reservoirs, and fifteen hydroelectric plants.

Even with its extensive distribution and storage system, Metropolitan's imported supplies can vary due to precipitation levels and water allocations by federal and state agencies. Currently, Metropolitan works with its member agencies to create a reliable water supply by investing in indoor and outdoor conservation programs, water transfers and exchanges, water recycling, groundwater cleanup and recharging, additional storage and other local water-saving programs.

Metropolitan's and Southern California's basic belief is that *every drop of water saved today can be stored for tomorrow*. Hopefully, your students and their families will feel the same way after using and enjoying *Water Times*.

For more information, please go to Metropolitan's Web site at www.mwdh2o.com.

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Metropolitan's Member Agencies



714-765-5137



310-285-2462



818-238-3550



Central Basin
Municipal Water District

310-217-2222



310-605-5595



818-790-4036



714-738-6890



818-548-2107



Inland Empire
UTILITIES AGENCY

909-357-0241



562-570-6555



213-367-4211



626-744-4005



818-898-1213



City of San Marino

626-289-7821



714-647-5400



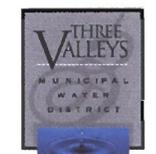
City of
Santa Monica

310-458-8224



San Diego County
Water Authority

858-522-6600



909-621-5568



310-618-6216



West Basin
Municipal Water District

310-217-2411



WESTERN
MUNICIPAL
WATER
DISTRICT

951-789-5000



805-526-9323



951-928-3777



818-251-2100



714-963-3058



UPPER SAN GABRIEL VALLEY
MUNICIPAL WATER DISTRICT

626-443-2297