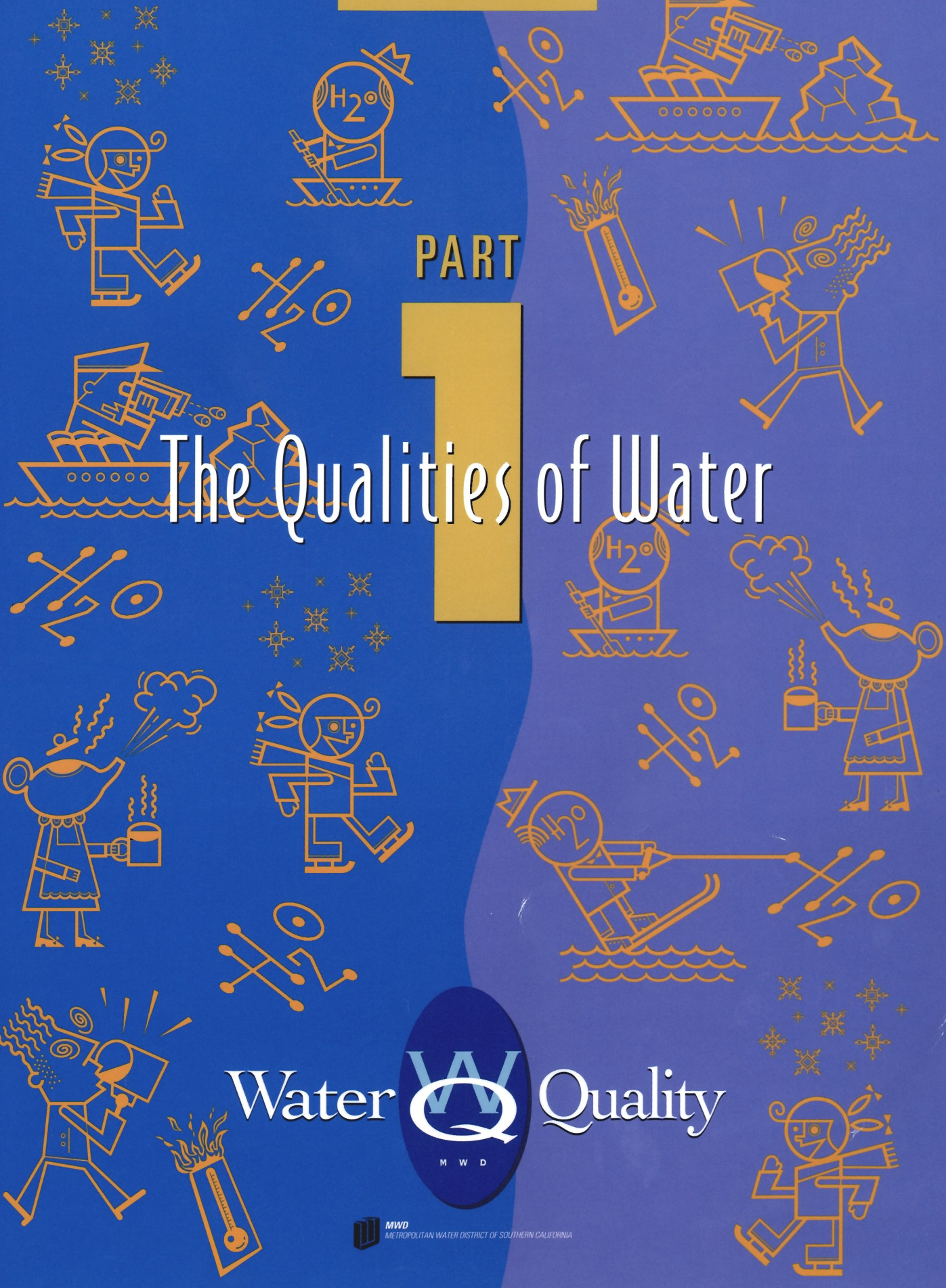
STUDENT BOOKLET



PART 1

The Qualities of Water

Water Quality

MWD

MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Southern California's Water

Why Should You Care About Water Quality?

Why should you care about the quality of water in nature? So what if a pond or river has poor water? Water is treated and purified before coming out of your tap, so a polluted pond or river doesn't affect you, does it?

Yes, it does! First of all, keeping our environment clean and healthy is extremely important.

Water quality helps determine the health of the environment. Healthy water supports healthy plants and animals, and water pollution is dangerous to the entire ecosystem. Since we depend on the "web of life," we suffer when the environment suffers. By preserving water resources for the environment, we preserve our own future.

In terms of drinking water, treating water costs money: the dirtier the water, the more it costs to make it drinkable. By taking care of our water resources, we save money.

In addition, the more intense the water treatment, the higher the health risks. By protecting our water from unnecessary pollution, we protect our own health.

The Metropolitan Water District of Southern California has prepared this water quality program to help you explore water quality in both our drinking water and in nature. After you experiment with the basic science of water, you will consider the huge role water plays in our society, in such dramas as environmental protection, public health, human welfare and conflicts of interests.

You may already share the conviction that it is important to care for our limited water resources. We hope this program gives you solid reasons to support that commitment.

The service territory of the Metropolitan Water District spans parts of six counties, from Ventura in the north to the Mexican border in the south.

Many People, Little Water

How would you describe Southern California's climate to someone from another part of the country?

You would probably use words like sunny, warm and dry. That is because you are describing a semi-arid desert. This pleasant climate has attracted many people and industries to our region.

Southern California has more than 16.5 million people and one of the largest economies in the world. On average, it receives only about 10 to 14 inches of rain each year, which is simply not enough to go around. In fact, the rainfall and groundwater aquifers of the area provide only about one-third of the water Southern Californians actually use.

Where does the rest of our water come from? Most of it is imported by the Metropolitan Water District of Southern California. Metropolitan serves parts of six counties: Ventura, Los Angeles, San Bernardino, Riverside, Orange and San Diego. If the area served by MWD were a state, it would be the third most populated in the country, next only to New York and Texas.

Only about one-third of Southern California's water comes from local water resources. The rest is brought into the region. This map shows the major aqueduct systems that supply water to the Metropolitan Water District.

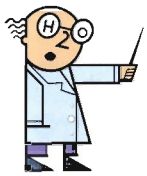
Metropolitan brings or imports water from the Colorado River through the Colorado River Aqueduct. It also imports water from the State Water Project, most of which comes from the Feather River in Northern California. That water flows into the Delta east of San Francisco where the Sacramento and San Joaquin Rivers come together. From there, it enters the California Aqueduct and flows through a system of dams and reservoirs into the massive distribution system that ultimately connects every home and business in Southern California.

On this long journey to your tap, water encounters many kinds of environments: dry sandy deserts, rocky mountains, lush forests, muddy flood runoff, farmlands of fertilized fields and livestock, superhighways, urban streets and factories. All of these environments affect water quality.

Let's begin our journey by learning about the strange and wonderful qualities of water – unusual properties that directly affect life on earth.

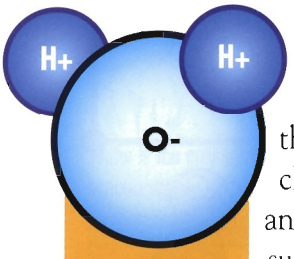
Earth: The Water Planet

Water has unusual and remarkable qualities. Without water, life on earth as we know it would be impossible.



Water Dissolves Rocks and Metals!

The water molecule is "polar," meaning that it has a positively charged pole and a negatively charged pole, just as a battery has positive and negative poles. The two hydrogen atoms carry a positive charge, and the oxygen atom carries a negative charge. The strength of the electrical charges in the molecule causes its precise shape: water's two hydrogen atoms rest 104.5 degrees apart.



The atomic structure of the H_2O molecule attracts other molecules, which then dissolve in the water. That is why water is the universal solvent.

Because the molecule has these two poles of opposite charge, it atttracts other polar and charged molecules. Those substances then "dissolve" in water. Most compounds are either polar or charged, so that is why so many substances dissolve in water and why it is called the "universal solvent." In fact, the only substances that do not dissolve in water are non-polar, such as grease and oil.

Water's ability to dissolve substances is essential to the life cycle of almost every organism. Plants and animals depend on the nutrients and minerals that dissolve in water. However, water can also dissolve substances that are harmful, such as heavy metals, insecticides and herbicides. When that happens, water is said to be polluted or contaminated. As water travels through the environment, it can spread this pollution, which can then be absorbed by plants or consumed by animals and people.

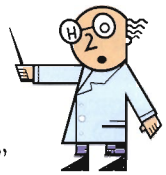
THINK ABOUT THIS: EVERYDAY EXAMPLES

What are some everyday examples of water's ability to dissolve a solid material?

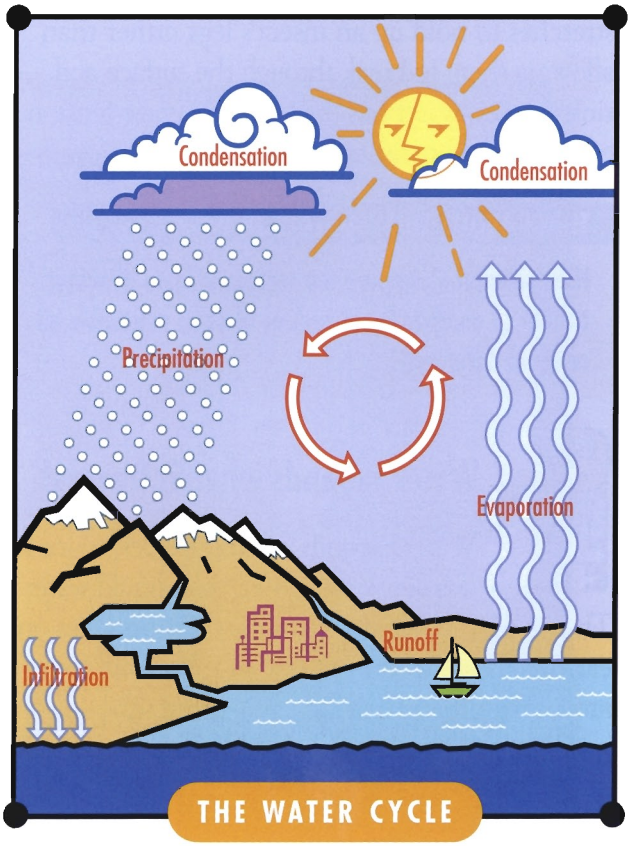
What evidence do scientists have that water can dissolve stone? Metal?

Could you devise an experiment that shows that water can dissolve a mineral?

Water Is Self Cleaning!



Even though water dissolves many substances, the water cycle "recycles" and cleans water. When water evaporates, that water vapor is pure H_2O again! The dissolved substances stay behind. As a result, a single molecule of water is continually purified.



If a whole body of water gets polluted, though, it is not so easy to clean. It holds the substances left behind when water evaporates. That is why protecting our water supplies from contamination is so important: once a water supply is polluted, it may stay polluted for generations.

THINK ABOUT THIS: PROVE IT!

How could you test the hypothesis that water can clean itself? Brainstorm a few ideas with the class and then try them.

Bugs can walk on water!

Water may flow freely, but it is very strong. That is, it has a strong *surface tension*. The molecules on the surface hold together and stretch like an elastic band. The surface stretches to hold up an insect's legs rather than allowing them to break through the surface and sink. In fact, water has the highest surface tension of any liquid on earth except mercury.

THINK ABOUT THIS: SURFACE TENSION

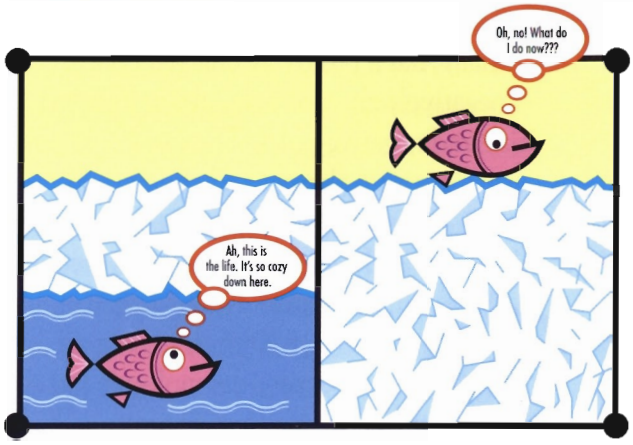
How could you compare the surface tension of water to that of another liquid such as alcohol, vegetable oil or liquid detergent?

Water expands when it freezes!

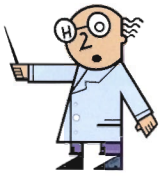
Water expands when it freezes, so ice is less dense, or lighter, than liquid water. That is why ice floats. Virtually all substances on earth contract as they freeze, so their solid forms are heavier than their liquid counterparts.

THINK ABOUT THIS: ICE

What would happen if ice sank? Name at least three reasons why life as we know it could not exist on earth if ice sank. Write a short science fiction story about a planet where ice did not float.



Water stores a lot of heat!



Do you think that "heat" and "temperature" mean the same thing? Consider this: When you strike a match, the tip gets hot very quickly, but it cools off almost as fast. A stone wall in bright sunshine reaches a lower temperature than a match, but it stays warm for a very long time. The match reaches a higher "temperature," but it cannot store heat. The wall holds more "heat" but does not get as hot. This ability to hold heat is called *heat capacity*.

Water has one of the highest heat capacities on earth. The oceans absorb the sun's heat during the day and release it slowly at night. They keep the earth's temperature relatively stable throughout the 24-hour day. Without the oceans, the planet's temperature would swing hundreds of degrees between day and night. Can you think of any plants or animals that could survive such temperature swings?

Desert climates have a milder version of the kind of temperature swings the earth would have without oceans. Desert air contains very little water, so it gets very hot during the day and cool at night. A moist climate does not change so dramatically from night to day.

THINK ABOUT THIS: TEMPERATURE AND MOISTURE

How could you demonstrate the effect that water has on the temperature of a landscape? Plan an experiment (either in the classroom or outdoors) by setting up or measuring two different types of "mini-climates" (one moist and the other arid) over a period of time. Predict what you expect to find, and compare your results.

Solid! Liquid! Vapor!

Water is the only substance on earth that exists as a vapor, liquid and solid in the earth's natural temperature range. In some climates, you can actually see water in all three *physical states* at the same time: a stream on a sunny winter morning can have water vapor rising from the water and ice crystals around the shoreline. (You may also experience this physical wonder when you open the freezer door to put in a new ice tray.)

Without this quality, we'd have no icecaps or glaciers storing fresh water; we'd have no water cycle; and without evaporation, water would not be able to cleanse itself. Because of the energy stored and released during phase changes, this quality keeps the earth's climate temperate and suitable for life.

Water is the only substance that can exist in all three physical states simultaneously – solid, liquid and vapor – at earth's normal range of temperature and pressure. Here it is shown in its three separate phases.

Water's Importance to Human Life and Health

When you look at the last century [1800s], the greatest advance [in public health] was not antibiotics. It was sanitation and the provision of clean water.

Dr. Graham Ogle, Australian physician

Turn on the tap. Take a drink. You don't like the taste? Go buy some bottled water. Life is hard here in the developed world! Most of us don't worry about dying from water; we worry about how it tastes. We take our drinking water for granted. What's more, we have lived this way for a century or so.

Throughout the world, 725 million people do not have clean drinking water. Roughly 35 percent of the people in developing countries have no toilets, so their drinking water supplies are often polluted with their own untreated waste. Boiling this polluted water could make it safe to drink. But many people do not know they should boil their water. Even if they did know, the wood and fuel needed for boiling water is often too rare or too expensive.

725 million people do not have clean drinking water. Cholera and dysentery kill more than 3 million people each year.

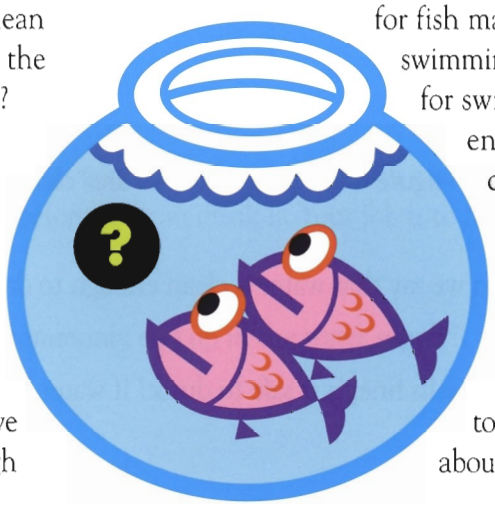
Untreated drinking water causes disease and death in many parts of the world.

As a result, untreated water is one of the largest killers in the world. Diseases carried by untreated water include *cholera* (kol'-e-ra) and *dysentery* (dis'-in-tery), which cause severe diarrhea and dehydration. These diseases kill more than 3 million people each year. Most of the victims are children.

What Does "Clean" Mean?

How do you know if water is clean enough to drink? Do you go by the way it looks? The way it smells? Most of us have faith that the water agency or bottled water company has made certain that the water is safe. But what if it were up to your own senses?

We all want "clean water," but the meaning of "clean water" depends on how we use it. Water that is clean enough for fish may not be clean enough for swimming. Water that is clean enough for swimming may not be clean enough to drink. Water that is clean enough to drink may not be clean enough to use in making computer chips.



In the following investigation, "Clean Enough to Drink?", you'll have a chance to make your own judgment about the cleanliness of water.

The water in this river may be clean enough for fish and swimming, but it must be purified before people can drink it.

Clean Enough to Drink?

INTRODUCTION

In this investigation, you will try to figure out if water samples are "clean" enough to drink.

Getting started

What does it mean when we say that water is clean enough to drink?

Make a prediction

If water looks clean and smells fine, is it safe to drink? If water looks cloudy or smells fishy, is it unsafe to drink?

Figure it out

① Your teacher will place several glasses of water in front of the room.

NOTE: FOLLOW GOOD LAB PRACTICE. DO NOT DRINK THIS WATER.

② Look carefully at each glass and record its appearance on the Clean Water Worksheet under "Appearance."

③ Does it look clean enough to drink? Would you drink it? Record your decision on the worksheet in the "Yes" or "No" bubble.

④ Now smell each glass and record your observation under "Smell."
NOTE: To smell, use the technique scientists use to protect their nostrils from chemicals that might burn. Place your face about four inches from the glass and use your hand to wave the scent toward your nose. This waving allows the scent to "waft" toward you. Take a few quick sniffs.

⑤ Decide whether you would drink this water based on the smell and record your decision under the second set of "Yes" or "No" bubbles.

⑥ Explain why you answered the way you did in your journal.

What does it mean?

① Do you think appearance and smell alone can tell you whether drinking water is healthy? Explain your response in your journal.

② After your teacher tells you what is in each glass, do you think you made the right decision about whether the water in each glass was clean enough to drink? Explain your response in your journal.

③ What might have happened if you had drunk the water? Which might have made you sick? Which might have just tasted awful, but would not have made you sick?

Talk it over

① Is looking at and smelling water a good way of finding out if it is safe to drink? Explain.

② What role might scientists play in determining if water is safe to drink?

Cleaning up the Mess

INTRODUCTION

Suppose you live in a small town that gets its drinking water from a river. The water in the river is polluted and needs to be treated before you can drink it. Your job is to find a way to clean it up.

Getting started

What pollutants might commonly end up in the water supply?

Make a prediction

① Can you clean up the pollutants?

② Would you need just one procedure or several?

Figure it out

① As a class, create a sample of polluted water with several forms of common pollutants.

② Divide into small groups and try to clean your polluted water.

③ Write down your group's procedure in your journal and explain why each step is necessary. Then try it.

What does it mean?

① Pour some of your cleaned water into a clear plastic cup and label it for your group. Compare the appearance and odors of the different water from the other groups. Explain your method to the other teams and find out about theirs. Were they successful in cleaning up their water? Were you successful?

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