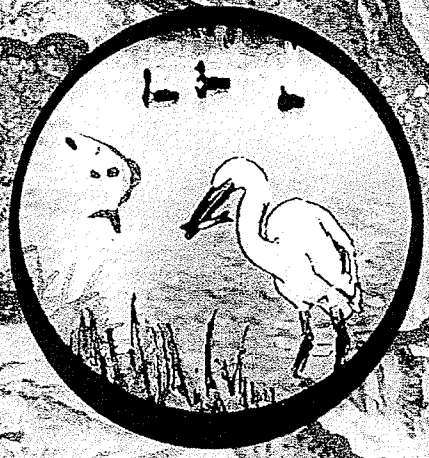
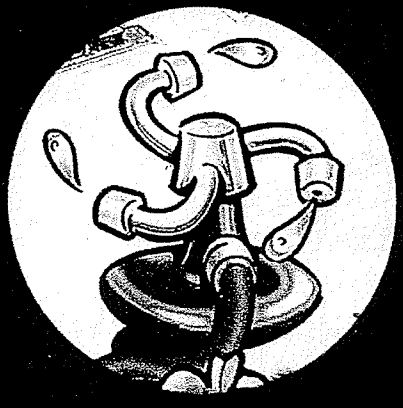
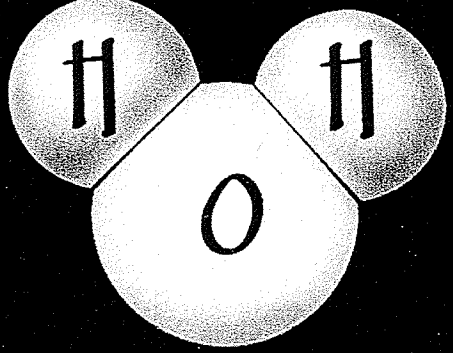
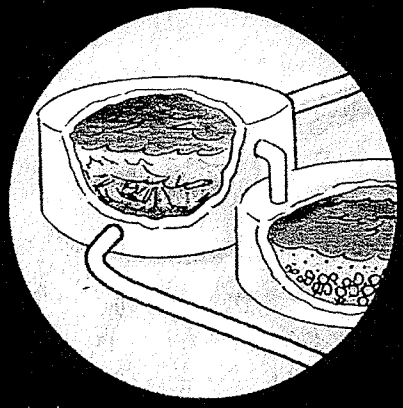
Item 8

Our Water Supply on the Monterey Peninsula









An Activity Book About Our Fresh Water Resources

Water

Water on the Monterey Peninsula is everywhere.

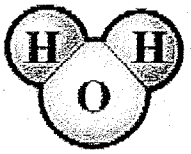
Water is a mountain lion sipping from a stream, fog rolling in on a hot summer day, winter storms rolling logs down the Carmel River, Monterey Pines growing tall.

Water is used to make almost everything. It brings us sweet juicy strawberries, pumpkins in the garden, grass for the soccer field, clean clothes, a warm shower, a bowl of noodles, water for the fire house, a refreshing drink.

For millions of years, water has traveled from clouds to the ground, down small creeks into our rivers, and into the Monterey Bay. Water shapes the land as it travels, creating the valleys and **lagoons** of the Monterey Peninsula.

Every single minute, water is being pumped out of the ground and the river so we can use it. We use water for almost everything we do.

Water is two hydrogen (H) atoms and one oxygen (0) atom bonded together as one molecule H20 in scientific terms.

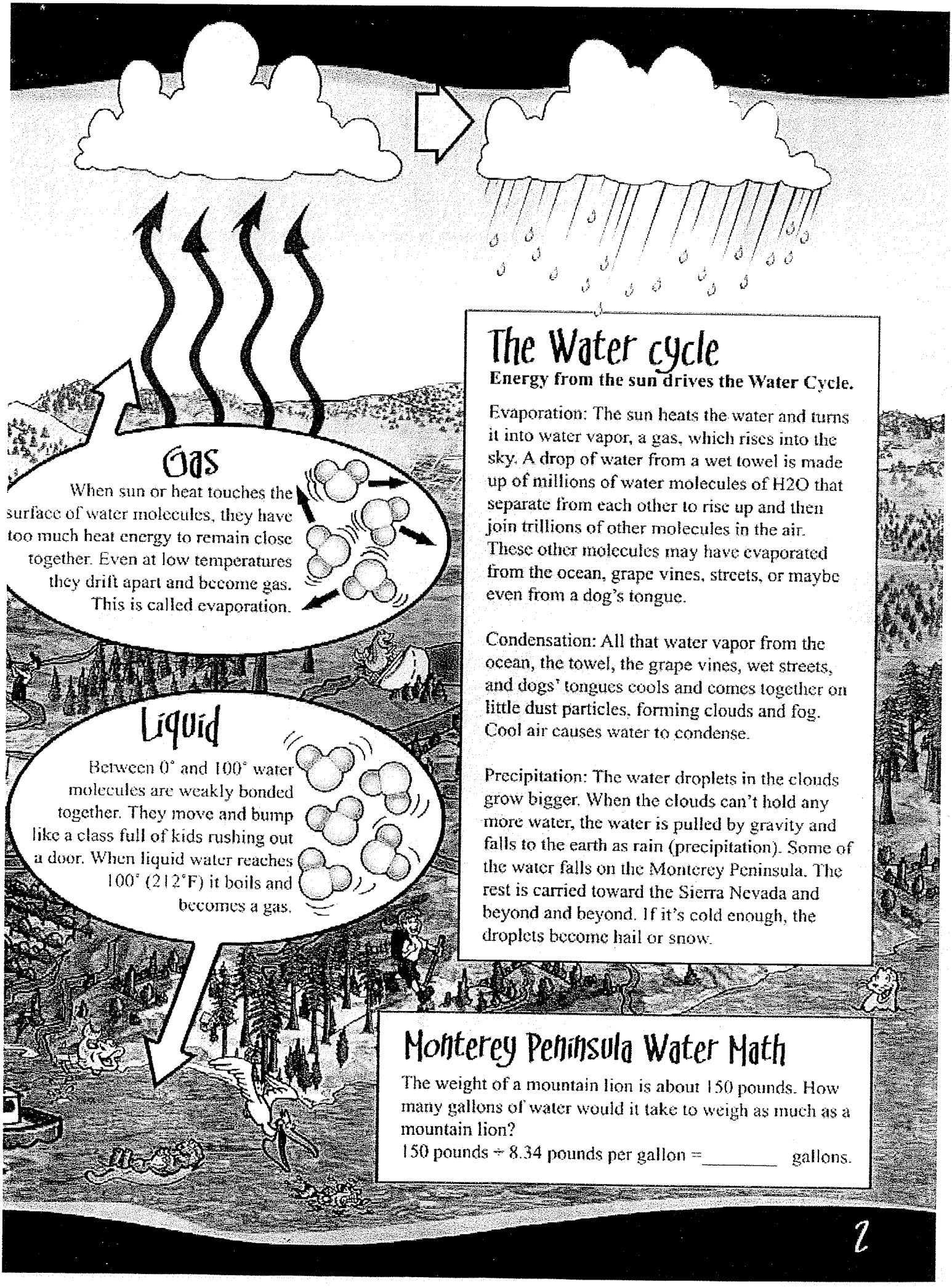


Solid (ice)

Below 0°C (Celsius) or 32°F (Fahrenheit) water molecules bond strongly to each other. These tight bonds make the water solid.

Monterey Peninsula Water Fact

Fog is our friend! If there was no fog there would be no Monterey Pine trees. About one-third of the year fog helps keep our trees alive. Fog gathers on pine needles and drips to the ground to feed the trees' roots. Especially during summer, fog gives our trees the water they need.



Gas

When sun or heat touches the surface of water molecules, they have too much heat energy to remain close together. Even at low temperatures they drift apart and become gas. This is called evaporation.

Liquid

Between 0° and 100° water molecules are weakly bonded together. They move and bump like a class full of kids rushing out a door. When liquid water reaches 100° (212°F) it boils and becomes a gas.

The Water cycle

Energy from the sun drives the Water Cycle.

Evaporation: The sun heats the water and turns it into water vapor, a gas, which rises into the sky. A drop of water from a wet towel is made up of millions of water molecules of H_2O that separate from each other to rise up and then join trillions of other molecules in the air. These other molecules may have evaporated from the ocean, grape vines, streets, or maybe even from a dog's tongue.

Condensation: All that water vapor from the ocean, the towel, the grape vines, wet streets, and dogs' tongues cools and comes together on little dust particles, forming clouds and fog. Cool air causes water to condense.

Precipitation: The water droplets in the clouds grow bigger. When the clouds can't hold any more water, the water is pulled by gravity and falls to the earth as rain (precipitation). Some of the water falls on the Monterey Peninsula. The rest is carried toward the Sierra Nevada and beyond and beyond. If it's cold enough, the droplets become hail or snow.

Monterey Peninsula Water Math

The weight of a mountain lion is about 150 pounds. How many gallons of water would it take to weigh as much as a mountain lion?

150 pounds ÷ 8.34 pounds per gallon = _____ gallons.

Water on the Surface

Trace the path of a water molecule

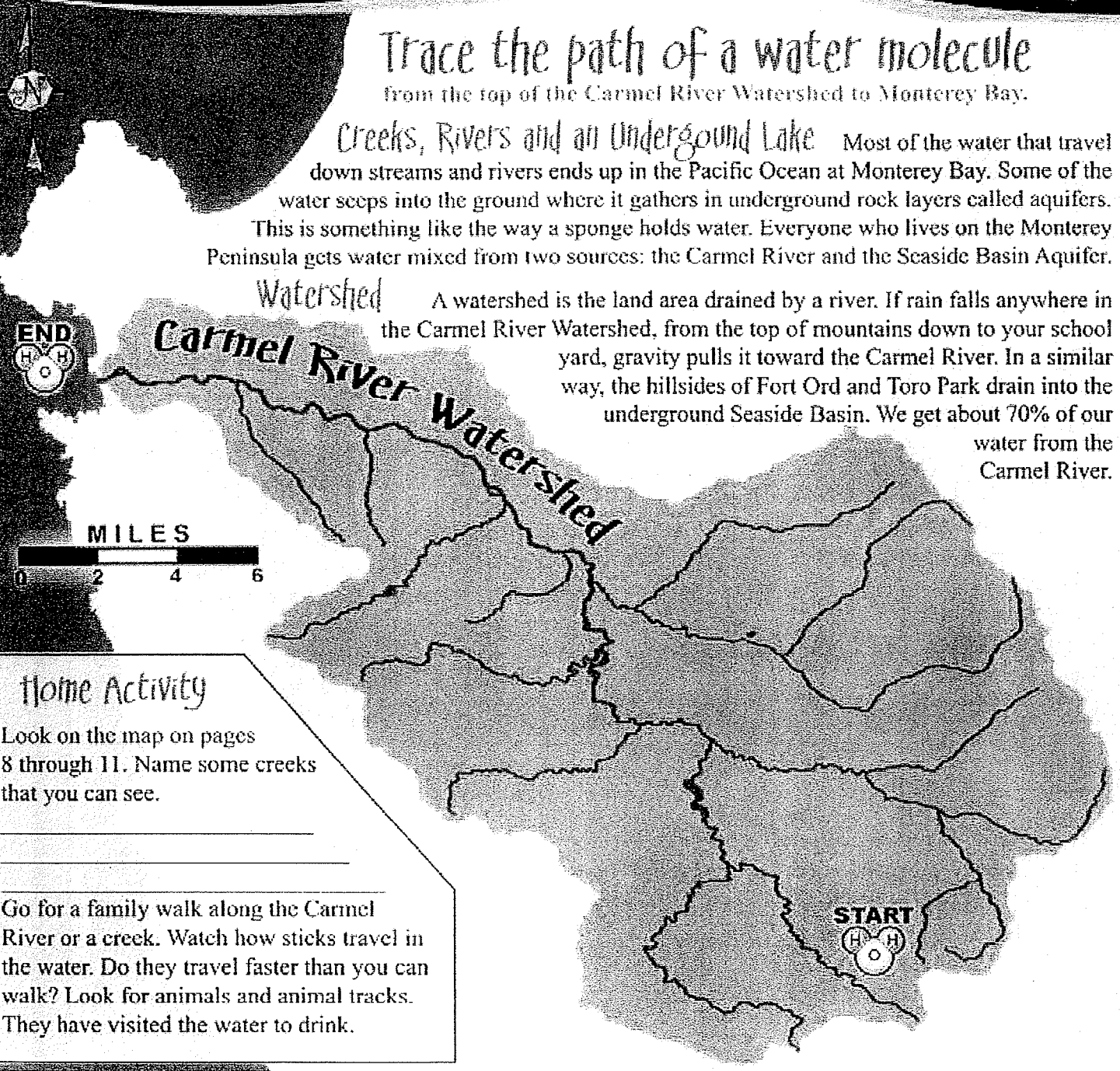
from the top of the Carmel River Watershed to Monterey Bay.

Creeks, Rivers and an Underground Lake

Most of the water that travel down streams and rivers ends up in the Pacific Ocean at Monterey Bay. Some of the water seeps into the ground where it gathers in underground rock layers called aquifers. This is something like the way a sponge holds water. Everyone who lives on the Monterey Peninsula gets water mixed from two sources: the Carmel River and the Seaside Basin Aquifer.

Watershed

A watershed is the land area drained by a river. If rain falls anywhere in the Carmel River Watershed, from the top of mountains down to your school yard, gravity pulls it toward the Carmel River. In a similar way, the hillsides of Fort Ord and Toro Park drain into the underground Seaside Basin. We get about 70% of our water from the Carmel River.



Home Activity

Look on the map on pages 8 through 11. Name some creeks that you can see.

_____

_____

_____

Go for a family walk along the Carmel River or a creek. Watch how sticks travel in the water. Do they travel faster than you can walk? Look for animals and animal tracks. They have visited the water to drink.

Monterey Peninsula Water Math

Water doesn't travel in a straight line down a river. It twists and bends. Water in the Carmel River bends its way for 36 miles from the mountains down to the ocean. It takes a water drop about six hours to travel 36 miles during a big storm. How fast is the water traveling in miles per hour (mph)?

_____miles + _____hours = _____mph.

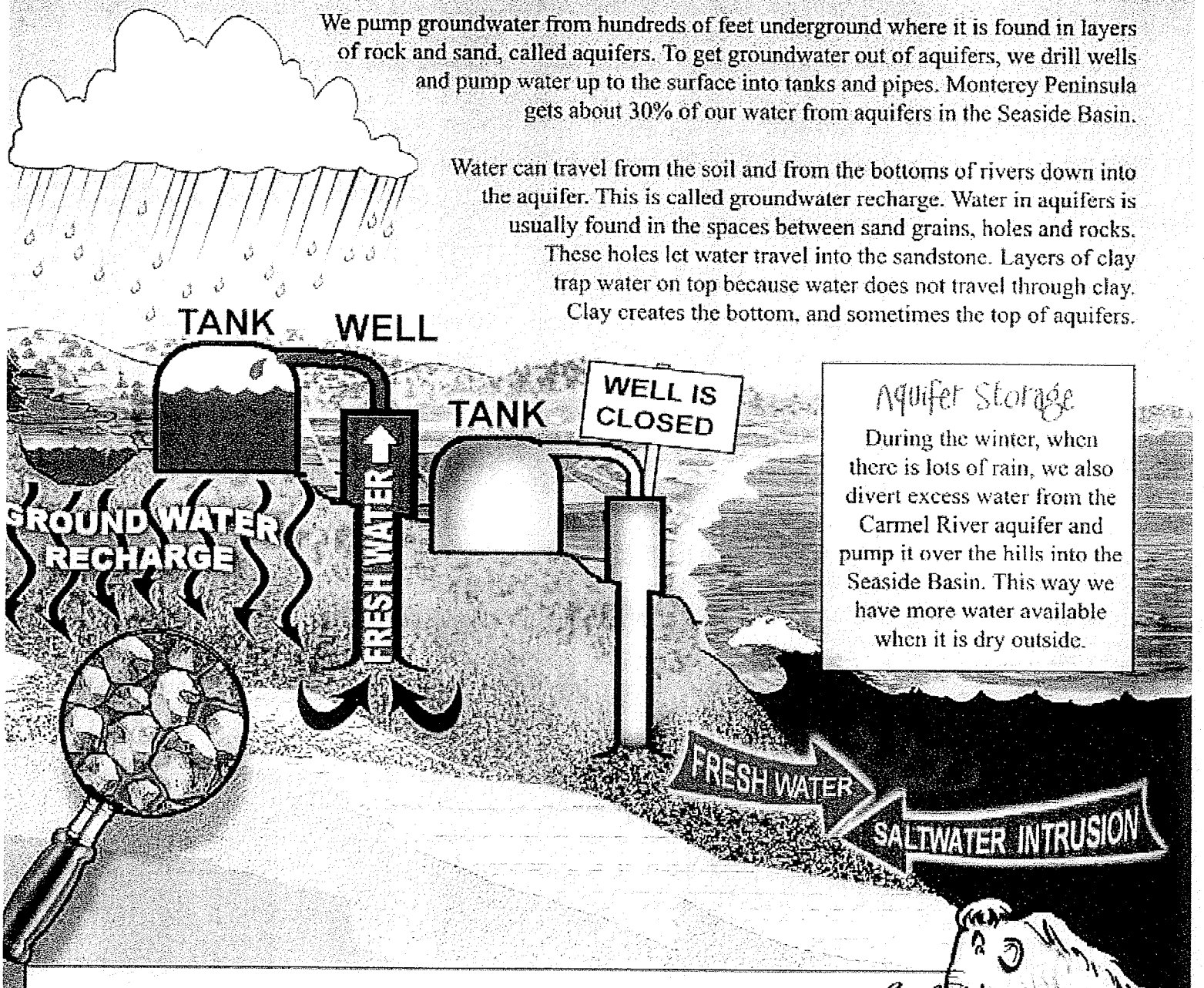
On a summer day, when it hasn't rained for a while, the trip could take 120 hours (5 days). How many miles per hour is this? _____ miles + _____hours = _____mph.
(The answer is less than 1 mph and can be written as a fraction or a decimal.)

Extra: Compare these speeds to how fast you walk. (If you walk 1 mile in 1/2 hour, you are walking at 2 mph.

Water in the Ground

We pump groundwater from hundreds of feet underground where it is found in layers of rock and sand, called aquifers. To get groundwater out of aquifers, we drill wells and pump water up to the surface into tanks and pipes. Monterey Peninsula gets about 30% of our water from aquifers in the Seaside Basin.

Water can travel from the soil and from the bottoms of rivers down into the aquifer. This is called groundwater recharge. Water in aquifers is usually found in the spaces between sand grains, holes and rocks. These holes let water travel into the sandstone. Layers of clay trap water on top because water does not travel through clay. Clay creates the bottom, and sometimes the top of aquifers.



Aquifer Storage

During the winter, when there is lots of rain, we also divert excess water from the Carmel River aquifer and pump it over the hills into the Seaside Basin. This way we have more water available when it is dry outside.

Groundwater Recharge

The water we pump from wells could have fallen onto the ground last year, or it could have rained down 2 million years ago, first rolling off the back of a wooly mastodon. The travel time depends on which path the water took through the ground to our wells.

Dangers to our Groundwater

Overdraft occurs when groundwater is used faster than it is recharged. Only a small amount of rainwater flows back into an aquifer. The Seaside Basin aquifers are in overdraft now and we need to fix that soon.

Seawater intrusion happens when saltwater seeps into the aquifer. When saltwater gets into the aquifer, that part of the aquifer is contaminated and may never be used again. Fruits and vegetables can't grow using water contaminated by salt ... and neither can kids.

The Story of a River

"The Carmel is a lovely little river. Frogs blink from its bank and the deep ferns grow beside it. Deer and foxes come to drink from it, secretly in the morning and evening, and now and then a mountain lion crouched flat laps its water." – John Steinbeck, "Cannery Row".

How have we used the Carmel River in the Past? How do we use the Carmel River today?

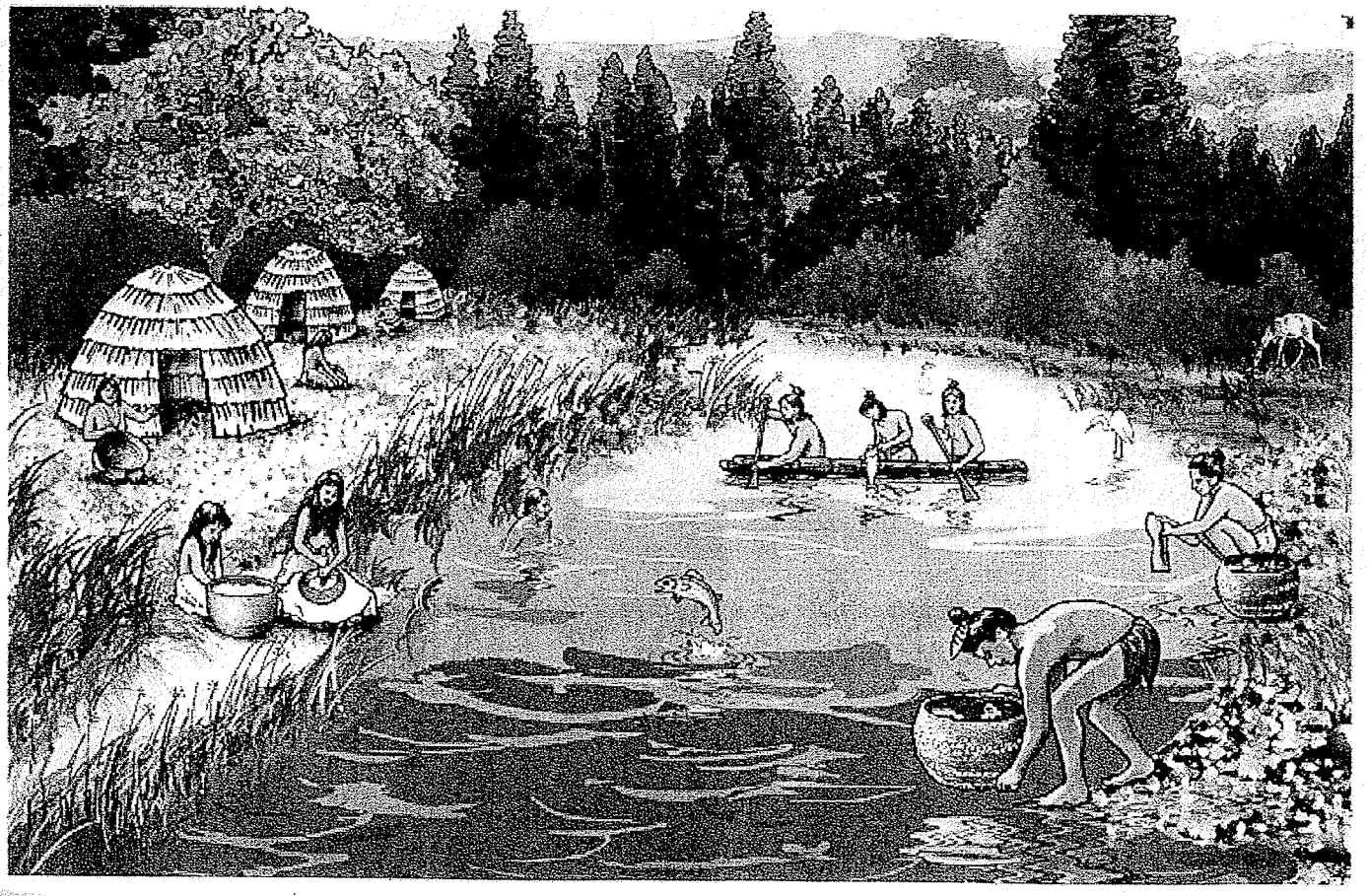
Look at these pictures of the Carmel River from different times in history. Mark the activities on the pictures with a letter from the Water Use Code. For example, put an F for food source next to the people fishing. There are many corret answers. Discuss your answers with others.

Water Use Code

- D Drinking and cooking water
- T Transportation
- R Recreation – play, sport
- F Food source – fish, livestock, irrigation
- P Power – saw mills, paper mills, water turbines
- W Washing – clothes, bodies, dishes
- O Other needs – carrying materials or waste
- M Manufacturing – making products using water

Native People

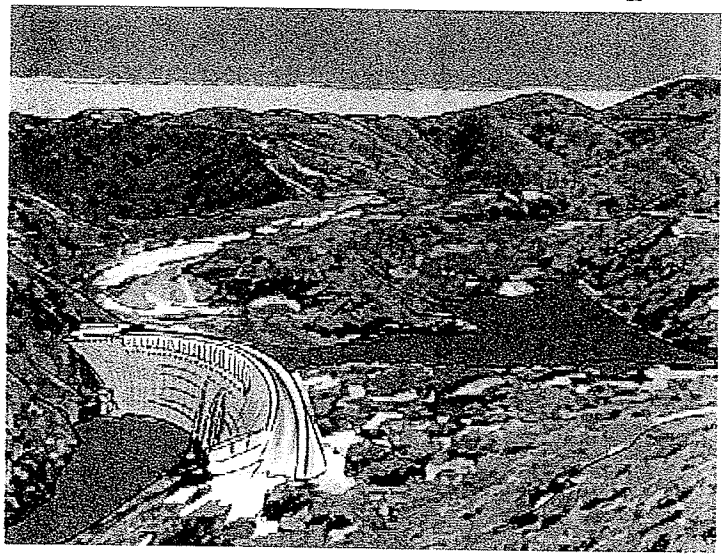
The traditions say that native people have always been here. **Archaeologists** believe that native people have been in California for at least 20,000 years. They lived in the Carmel and Monterey areas fishing and hunting and gathering nuts, berries and bulbs for food.



1603 to 1785: Spaniards bring water from the Carmel River

Spanish explorers named a stream "El Rio de Carmelo" (the Carmel River). In 1770, Father Junipero Serra arrived by sea and was joined with a Spanish army group. But there was very little water to irrigate crops, so food was a problem. Between 1777 and 1783, the Spaniards and native people built an irrigation canal.

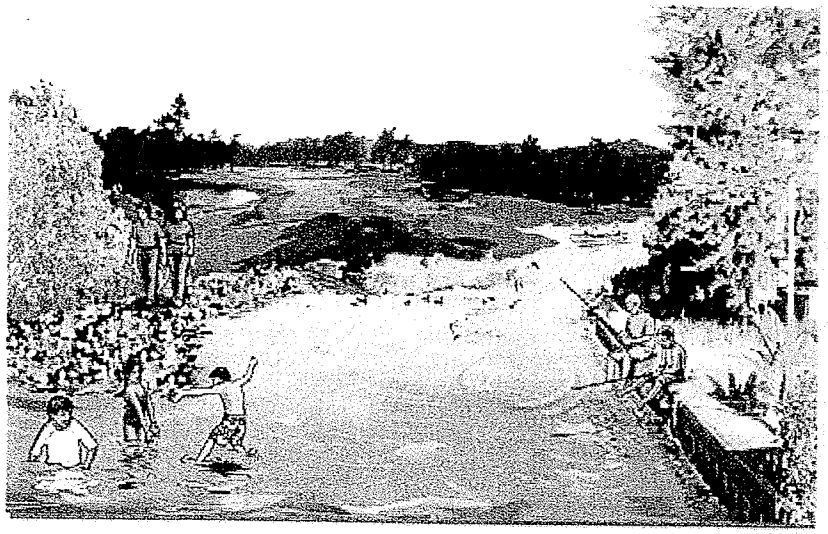
1883 to 1948: Building dams to help the community grow



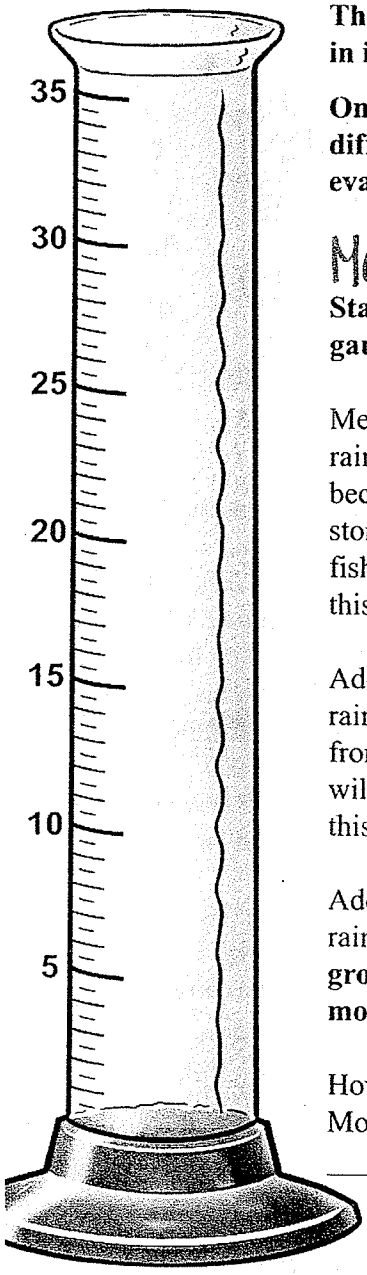
The Monterey Peninsula really began to grow in the 1880s. Fishermen and their families settled here, becoming the largest source of jobs in the area. The first tourist hotels were built, and people began coming down from San Francisco. As more people moved to our area, more drinking water was needed. With no dams on the Carmel River, water runs to the ocean in winter, but there is no way to store it for use in dry months. In 1883, Chinese laborers built the first known dam and placed an iron pipe down Carmel Valley and around the coast to Monterey. In 1921, the San Clemente Dam was completed just upstream of the original dam near Carmel Valley Village. In 1948, Los Padres Dam was built near Cachagua with mules and just one bulldozer.

Today

The Carmel River is our community's main source of water. But we need to use the river carefully. Steelhead trout and frogs could lose the **habitat** they need to survive. Gravel has been added to the river bed to help steelhead spawn. Pebble Beach golf courses use the **reclaimed water** instead of fresh water. Rescuing stranded fish and improving their habitat is improving their lives. The community is developing projects like a desalination plant to serve our area. Also, new wells are being created in the Seaside Basin. Together, these projects will reduce the use of the Carmel River in the future.



How much rainwater can we use?



This is a picture of a rain gauge. A rain gauge measures how much rainwater falls in inches. Each dark line equals one inch of rain.

On this rain gauge, you are going to divide the county's annual rainfall into four different parts. Each part will show a place where rainwater goes—runoff, evaporation, groundwater, and human use.

Measure and Color

Start at the bottom and fill up the rain gauge.

Measure **5.5 inches**. Color this part of the rain gauge blue. This water is called **runoff** because it runs off into rivers, creeks and storm drains and then to the ocean. The fish, amphibians, and other wildlife use this water to live.

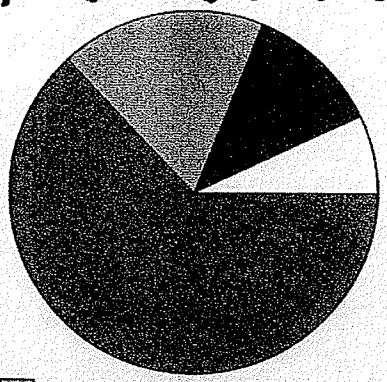
Add on **13.0 inches**. Color this part of the rain gauge green. This water **evaporates** from the ground and plants. Plants in the wild, on our farms, and in our gardens use this water to live.

Add on **3.0 inches**. Color this part of the rain gauge purple. This water travels to **groundwater** aquifers. **We are pumping more than this from aquifers each year.**

How many total inches of rain does the Monterey Peninsula get in one year?

_____inches

Monterey Peninsula Human Water Use



Residential – 63%
11,247 Acre-Feet/Year or AFY

Industrial/Commercial – 18%
3,203 Acre-Feet/Year or AFY

Golf Courses – 12%
2,152 Acre-Feet/Year or AFY

Public/Other – 7%
1,096 Acre-Feet/Year or AFY

Total = _____acre-feet

Monterey Peninsula Water Math: Imagine How Much Water We Use Each Year

Large amounts of water are measured in **acre-feet**. One acre-foot is the area of an adult soccer field covered with one foot of water. Monterey Peninsula uses 17,698 acre feet of water each year. If this water was spread over all the country, we would be standing in 212,376 inches of water.

But what if it wasn't spread out? Imagine a fifty story building covering that soccer field. Each story is ten feet tall. So you have 500 acre-feet for one building (50 stories X 10 feet/story). How many building would it take to hold 17,698 acre-feet of water?

17,698 acre-feet ÷ 500 acre-feet per building = _____buildings

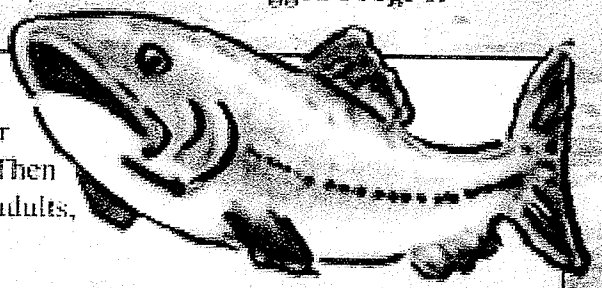
Water for the Monterey Peninsula: The Big Picture

Fish and frogs and butterflies (Oh my!)

Some animals and insects that live in or near the Carmel River are threatened with **extinction.** Very few South-Central California Coast **Steelhead Trout,** California **Red-legged Frogs** or **Smith's Blue Butterflies** are still alive.

Steelhead

Steelhead are a special kind of Rainbow Trout similar to salmon. Steelhead are born in the Carmel River. Then they move to the ocean to live or a year or more. As adults, they return again to the Carmel River.



- Steelhead return upstream from December to May to their birthplace to lay and fertilize eggs in **tributaries** and throughout the Carmel River.
- Fish traveling upstream beyond the San Clemente Dam must jump up a series of concrete pools that lead 84 fee to the top of the Dam.
- Some Steelhead return above Los Padres Dam another six miles upstream.
- Swimming into holding traps, they're gently removed by California American Water staff and then placed into a tanker truck, and released behind the Los Padres Dam.
- The fish then turn upstream to find gravel areas where they can spawn in the many **tributaries** that drain the watershed above Los Padres Dam.
- Newborn steelhead grow rapidly and most remain in the fresh water of the Carmel River two years before they swim back into the ocean, completing their life cycle.

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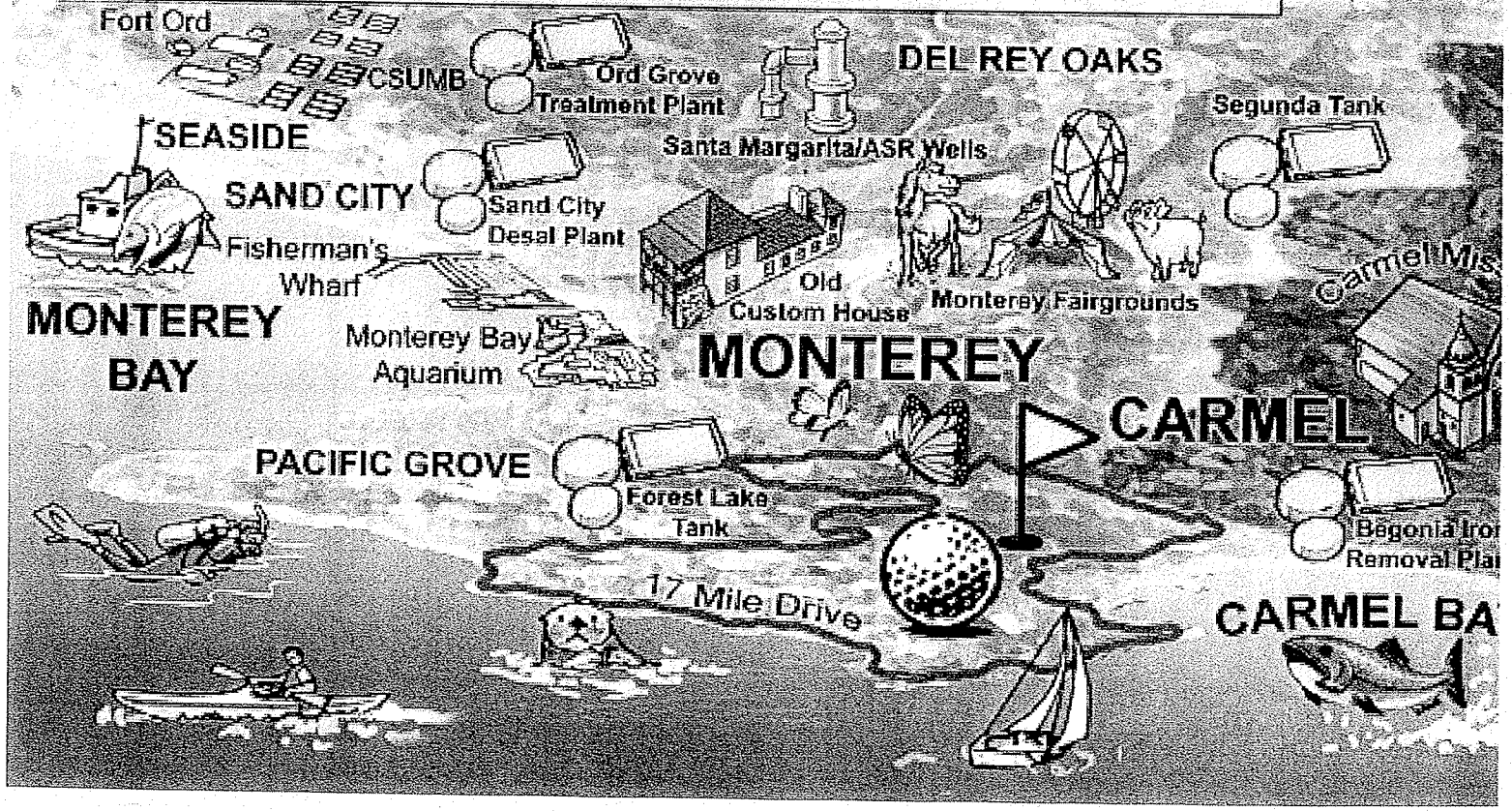
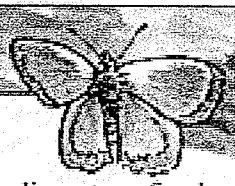


d Frogs

and Wildlife Service and California American Water have a program for long-term protection. location of California Red-legged frogs during the heat of summer. Water releases from San Clemente Dam l specifically to improve breeding conditions for the native California Red-legged Frogs. At the same npany is removing non-native predators, specifically the Bull Frog.

ue Butterfly

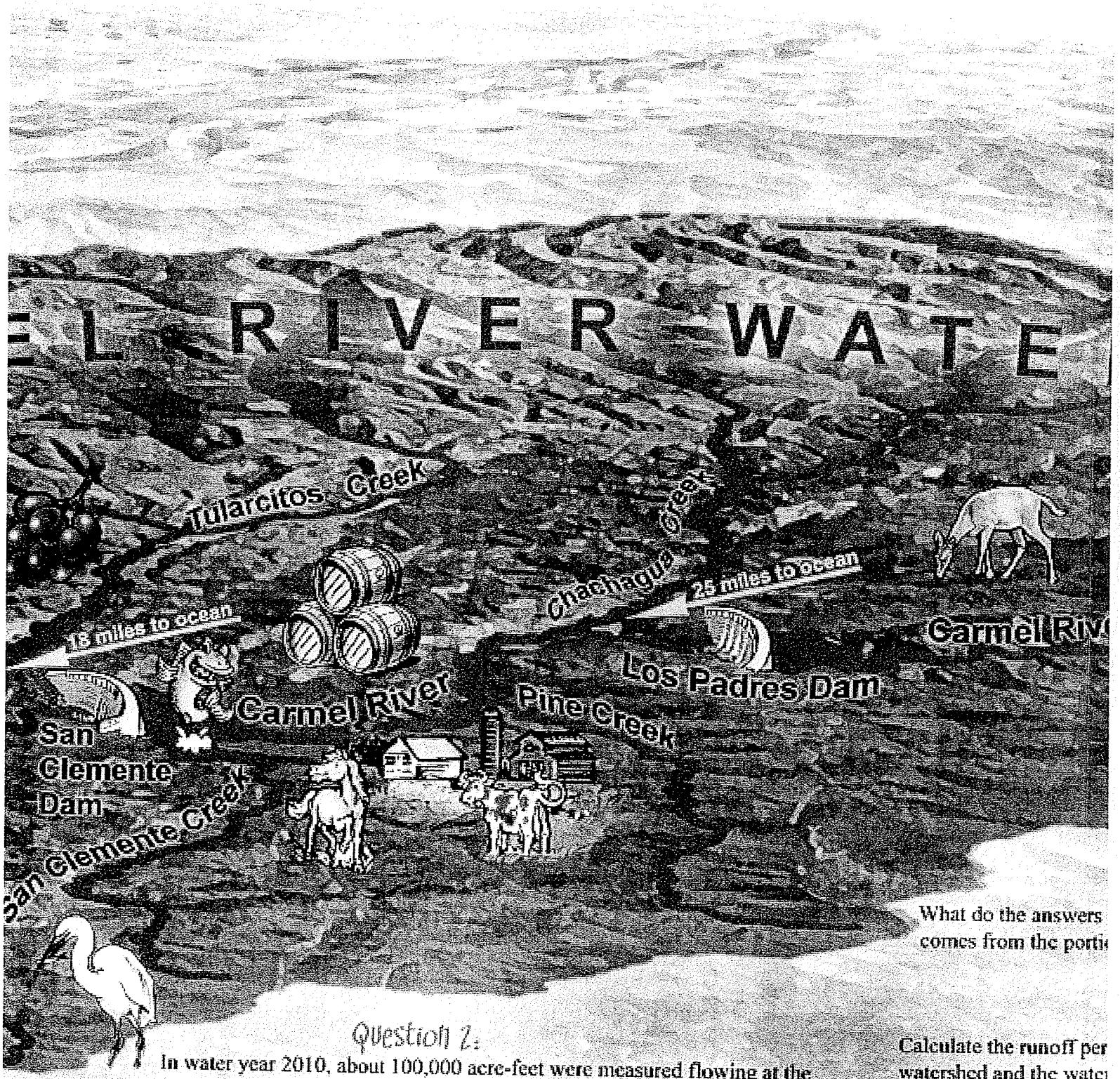


butterfly, with a wing diameter of only one only in a few places on the Central California blue butterfly became one of the first insects to be an endangered species. Smith's blue butterfly depends e plants, Coast and Dyunes Buckwheat, during all stages ing its one-week lifespan, the butterfly feeds, mates, and lays he flowers of these buckwheats. In exchange, the adult butterflies uckwheat flowers. Protecting this buckwheat is necessary butterflies alive.

Question 1:

The total area of the Carmel River watershed is about 250 square miles. The portion of the watershed upstream of Los Padres Dam is about 45 square miles. What percentage of the land mass of the watershed occurs upstream of the dam?

P A C I



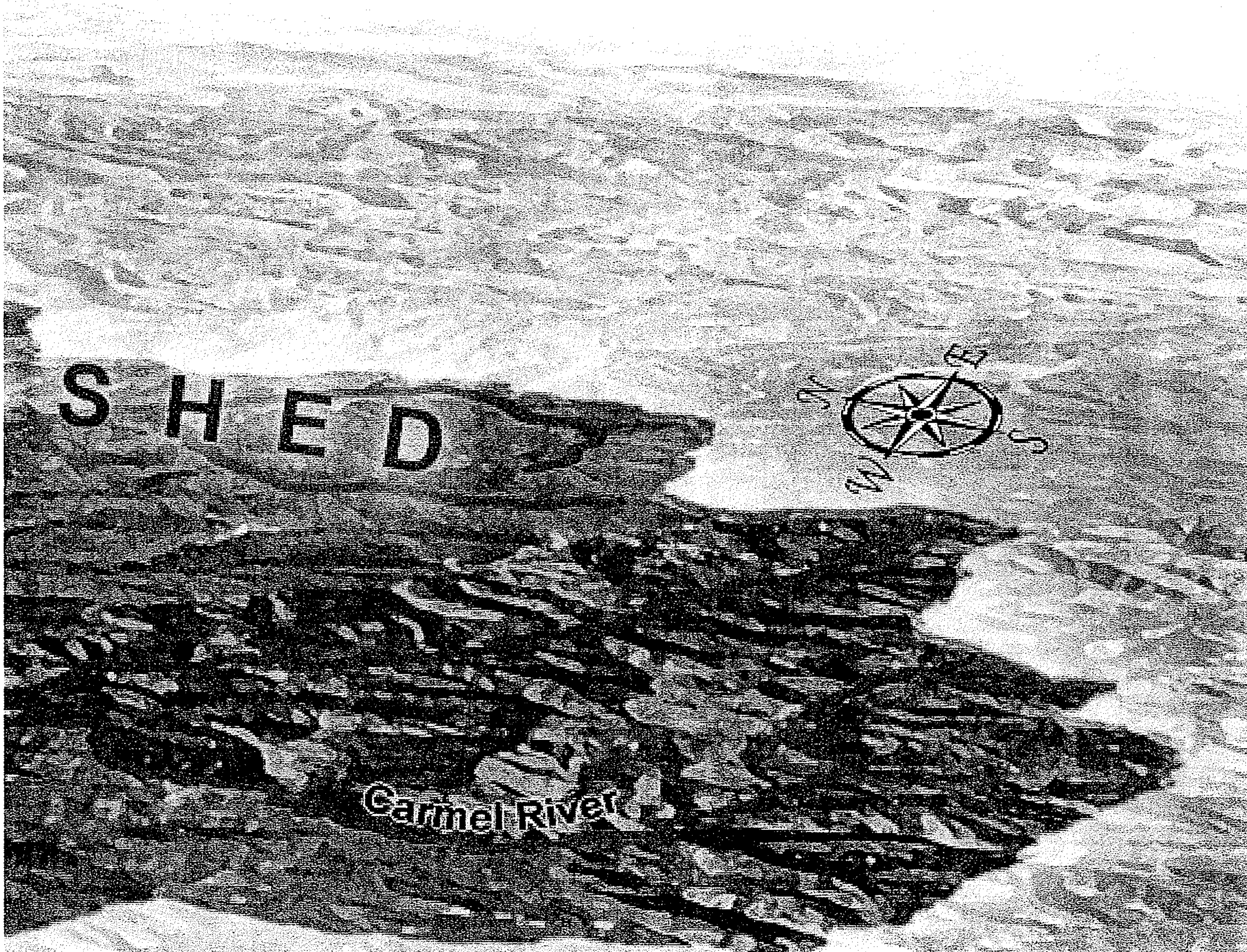
What do the answers
comes from the portic

Question 2:

In water year 2010, about 100,000 acre-feet were measured flowing at the mouth of the Carmel River near Carmel Bay. This reflects runoff from all of the Carmel River wate shed. That same year, about 70,000 acre-feet were measured flowing by Los Padres Dam, which reflects the most upstream portion of the watershed (like one piece of a puzzle). What percentage of Carmel River water flow comes from the portion of the watershed upstream of Los Padres Dam?

Calculate the runoff per
watershed and the wate

The answers to Q1 and
mile occurs in the upper
of the water flow). Why



Question 3:

l and Q2 tell you about water flow that
'the watershed upstream of Los Padres
Dam?

Question 4:

re mile of the upper portion of the
l as a whole. How do they compare?

Question 5:

ll us that much more runoff per square
ershed (18% of the land produces 70%
ou think this occurs?

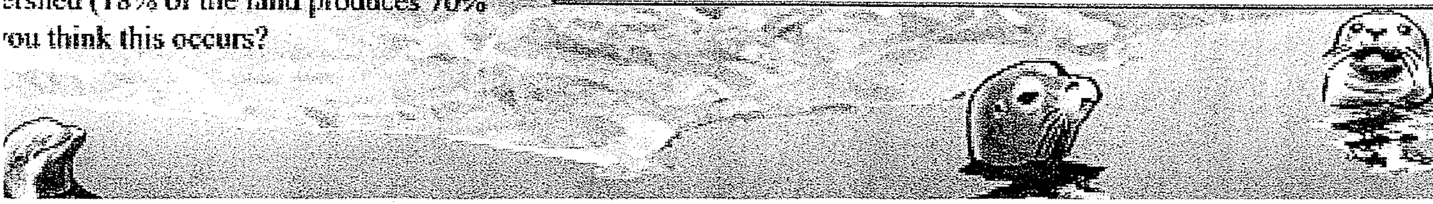
Answer 1: 18% [45/250=0.18=18%]

Answer 2: 70% [70,000/100,000=0.7=70%]

Answer 3: Given its smaller size, a lot more water than you would expect comes from the upper watershed (only 18% of the land mass produces 70% of the water flow). Put more specifically, the runoff per square mile is much higher.

Answer 4: Portion upstream of Los Padres Dam = 1,556 AF/sq. mile (70,000 AF/45 sq mi=1556) Total watershed = 400 AF/sq mi (100,000 AF/250 sq mi = 400)Thus, the upper watershed subarea produces nearly four times more streamflow as compared to the watershed as a whole (1556/400 = 3.89)

Answer 5: The main reasons are: (1) the coastal mountains generate more rainfall (orographic effect), and (2) the steep terrain in the rugged Ventana Wilderness results in greater runoff than in flatter areas.



How much water do you use each day?

Estimate how many gallons of water you use in a day. _____ gallons

Example: Use this chart to calculate your water use indoors by tallying your number of uses in one day.

If you flush the toilet 4 times per day: 4 flushes x 3 gallons per flush = 12 gallons

Your Daily Indoor Water Use

Activity	Number of Uses or Minutes	x	Average Use (gallons)	=	Your Use (gallons)
Drinking	____drinks	x	0.1 gallons per drink	=	
Cooking	____meals	x	.2 gallons per meal	=	
Washing dishes by hand			5 gallons per day	=	
Dishwasher			4 gallons per day	=	
Toilet	____flushes	x	† Conventional toilet: 3.5–5 galls per flush **High efficiency toilet: 1.28 galls per flush**	=	
Hand washing	____washes	x	1 gallon per wash	=	
Showers	____showers	x	† Older shower head: 3–8 gallons per minute **High efficiency head: 1.5 gallons per minute**	=	
Baths	____baths	x	25 gallons per bath	=	
Teeth brushing	____brushings	x	0.5 gallons per brush	=	
Load of laundry*	____loads	x	† Standard washer: 35–45 gallons per load **High Efficiency washer: 15 gallons per load**	=	
Other	_____	x	_____	=	
			Total		

* Divide weekly loads by 7 days to get number of daily loads.

† Find out whether your house has conventional or high efficiency.

Compare your total calculation with your estimate. How close were you?

Home Activity: Check Your Water Bill

Your water may be measured in "units."
1 unit = 789 gallons. Divide your family's daily water use by the number of people in your family.

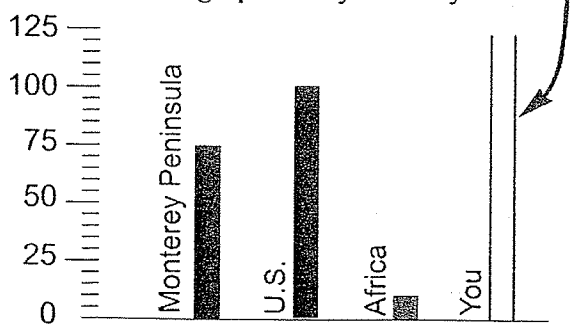
_____ **gallons per day for family**
÷ _____ **people in family**
= _____ **gallons per person per day**

Does it match with your daily total? _____

Remember, the water bill includes outdoor water use.
How does your use compare with the Monterey Peninsula average use of 75 gallons per person per day?

Water Use per Person per Day

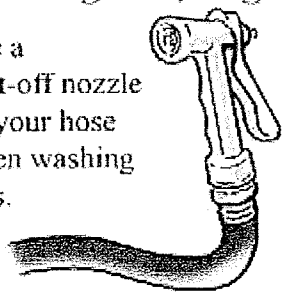
Fill in the bar graph with your daily total.



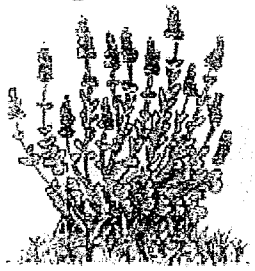
Saving Water at Home

Circle the water saving activities that your family does.
Put a square around activities that your family wants to begin doing.

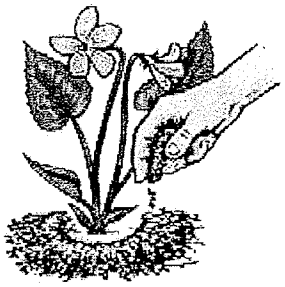
Water your yard and outdoor plants early or late in the day to reduce evaporation.



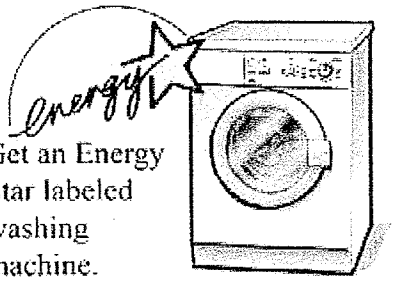
Use a shut-off nozzle on your hose when washing cars.



Use plants that require less water.

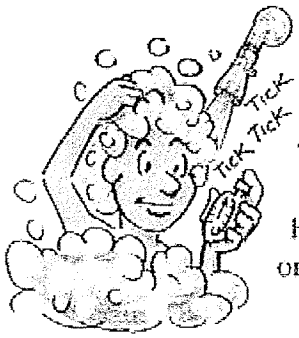


Mulch around plants to hold water in the soil.

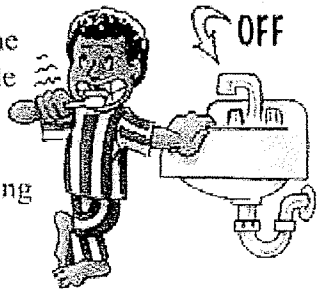


Get an Energy Star labeled washing machine.
Wash only full loads.

Use a low flow showerhead.

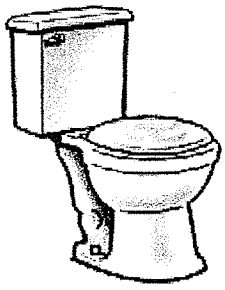


Take shorter showers--
Five minutes or less is best.

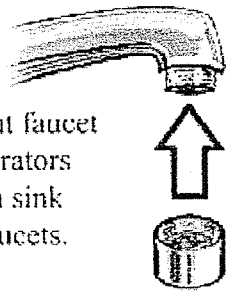


Turn off the water while soaping hands and brushing teeth.

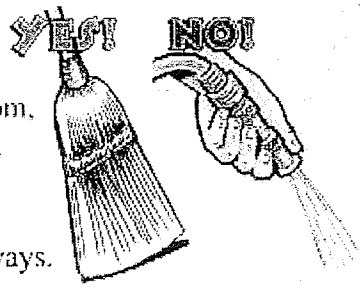
Turn off sink faucet while scrubbing dishes and pots.



Replace old toilets with ultra low flush toilets.



Put faucet aerators on sink faucets.



Use a broom, not a hose, to clean driveways and walkways.

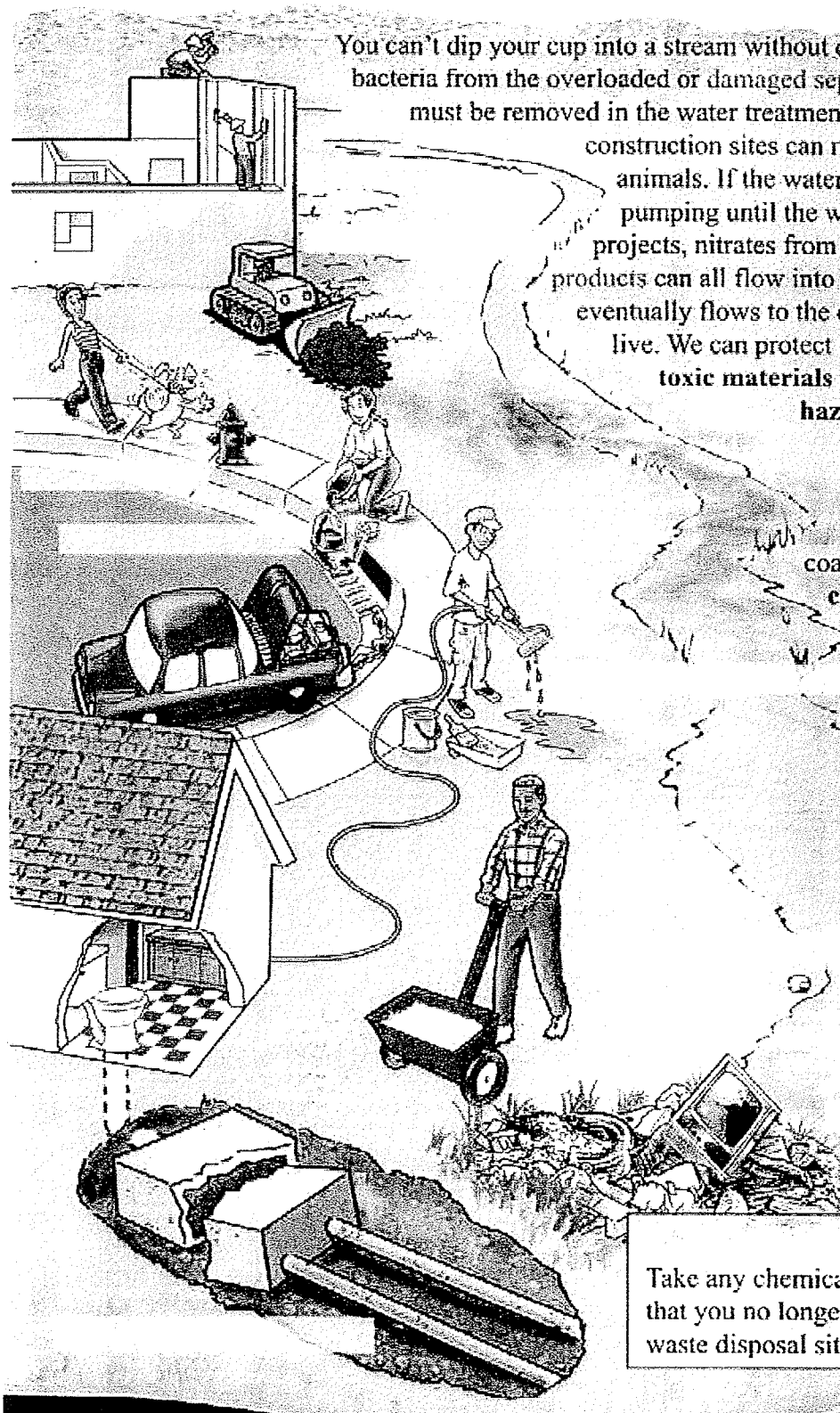
Your idea _____

Monterey Peninsula Water Fact

Most of our water is used outdoors. Many people are now changing away from grass lawns to use plants, flowers, and trees that can live using very little water. And they are pretty, too!

Preventing Water Pollution

Read about how water can get dirty.
Find the **purple** words in the paragraph. **Label** the pollution in the picture.



Rivers, Streams and the Ocean

You can't dip your cup into a stream without danger of getting sick. A lot of streams contain bacteria from the overloaded or damaged septic tanks and from animal poop. This bacteria must be removed in the water treatment process. Dirt and gravel from road and home construction sites can muddy the streams, damaging habitat for water animals. If the water is too muddy, the water agencies have to stop pumping until the water clears. Paint and chemicals from building projects, nitrates from fertilizers, garden chemicals, garbage, and car products can all flow into streams and storm drains. This **polluted** water eventually flows to the ocean where we play and where many animals live. We can protect our surface water and ocean by using the **least toxic materials** possible around our homes and by taking used **hazardous materials** such as paint and cleansers, to household hazardous waste stations.

Aquifers

The greatest danger to wells near the coast is **seawater intrusion**. Aquifers can also be **contaminated** from agricultural fertilizers, and toxic chemicals from leaking fuel and chemical storage tanks.

Tap Water

The water that comes out of your tap is safe to drink. It has been filtered, treated, and tested in the lab to make sure there are no pollutants. If water agencies find that the water they are taking out of a well or stream is contaminated, they must close that well or quit taking water from that stream.

Please help keep our water clean.

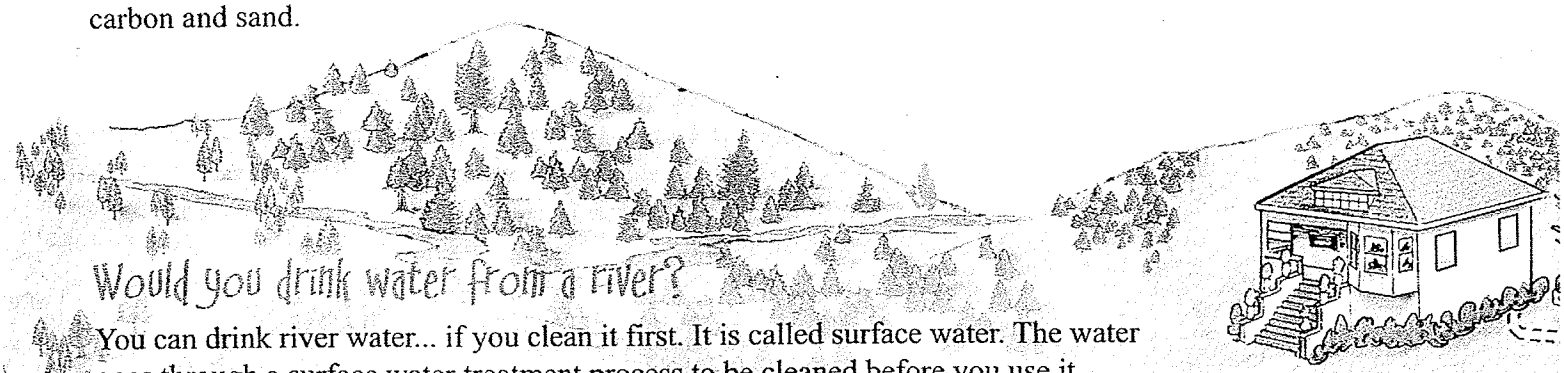
Home Activity

Take any chemicals (house paint, solvents, cleaning products) that you no longer need and used batteries to our hazardeous waste disposal site. For more information, call 831-384-5313.

From the River and the Well to Your Faucet

Would you drink water from the ground?

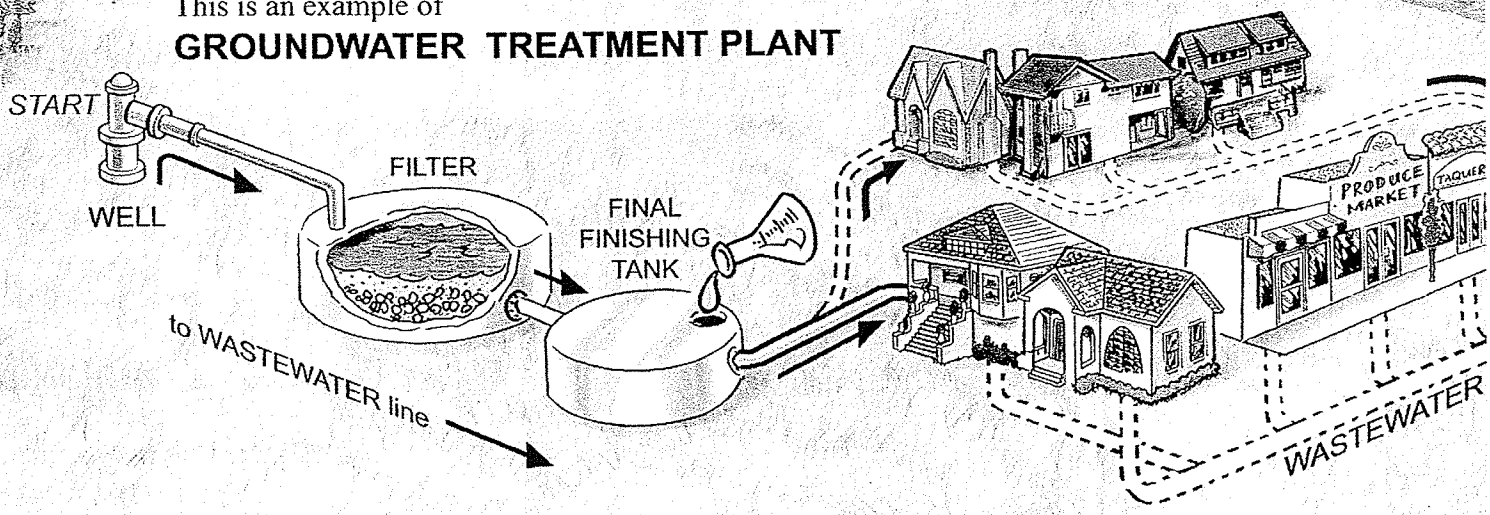
Yes, it's called **groundwater**. Most of the water used in Monterey County comes from the ground. Water from wells could have been in the ground for a thousand years, or have arrived in last winter's storms. For water rights purposes, the State Water Board has categorized water extraction from the Carmel Valley Alluvial Aquifer as "surface water." Water coming from wells is usually clean because it has been **filtered** naturally as it goes through the ground. Generally it only needs a little bit of chlorine added. Some well water also needs to be filtered with carbon and sand.



Would you drink water from a river?

You can drink river water... if you clean it first. It is called surface water. The water goes through a surface water treatment process to be cleaned before you use it.

This is an example of
GROUNDWATER TREATMENT PLANT



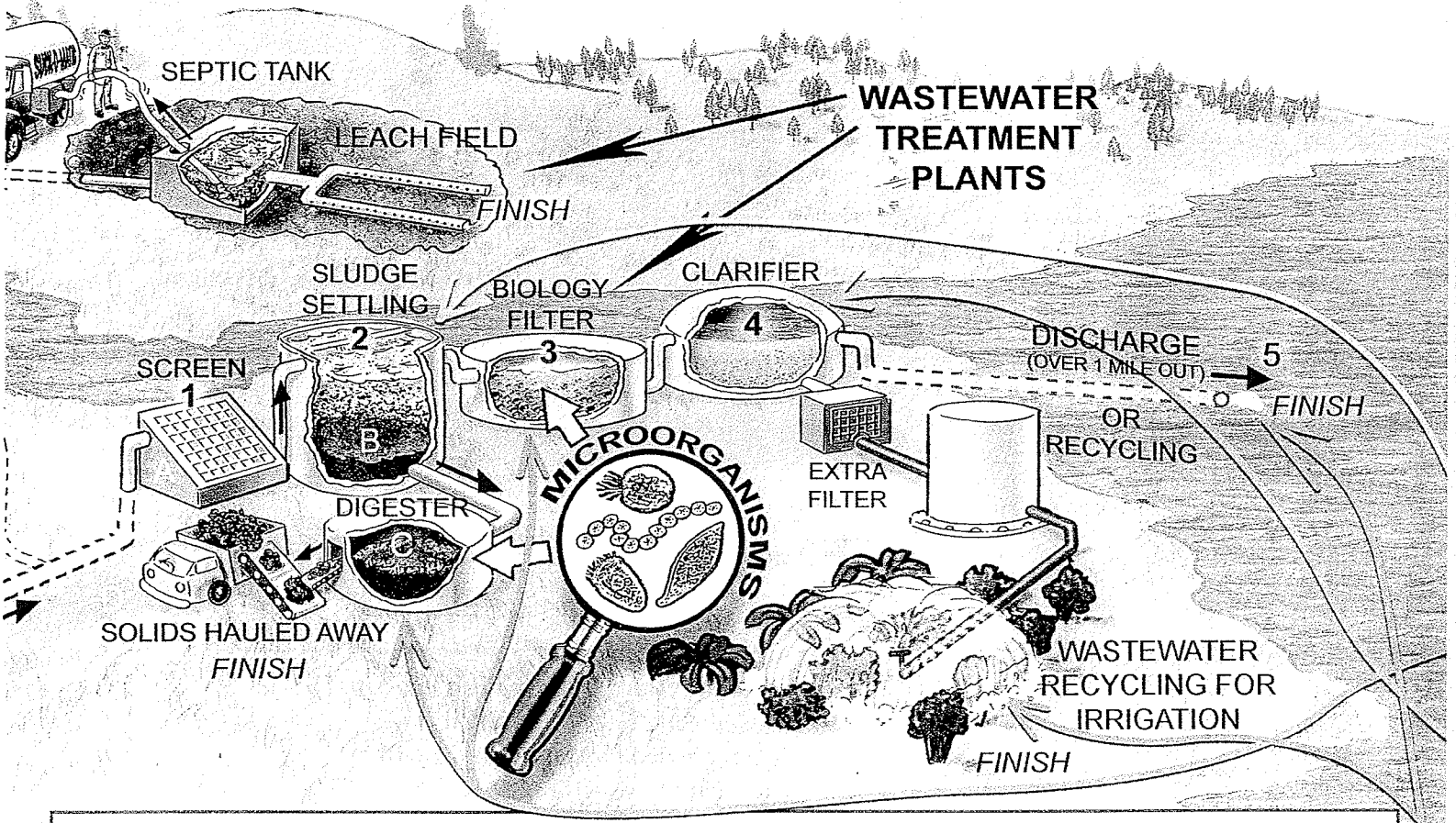
STEPS	WHAT'S HAPPENING	REASON
Well	Water is pumped out of the ground.	
Filter	Water is run through layers of anthracite coal, sand, and gravel.	This removes any remaining particles.
Final Finishing Tank	Chlorine and phosphate is added.	Chlorine kills any harmful bacteria. Phosphate prevents pipes from corroding.

Wastewater Treatment Plants

We take showers, flush toilets, wash our hands, boil noodles, scrub dishes, mop floors, and do the laundry. By the end of the day a lot of water has gone down the drain. The used water is now called wastewater and has to be cleaned. In rural areas, wastewater is treated in septic systems. City or suburban wastewater goes to a wastewater treatment plant.

Septic Systems: Mini Water Treatment Plants

In septic systems, micro-organisms eat the harmful bacteria in wastewater. The water is filtered through gravel and soil and returned back to the ground and eventually to streams or aquifers. When septic tanks get full, the sludge is pumped out and taken to the big wastewater treatment plant.



Label the names of the steps in treating and cleaning wastewater

SOLIDS

A. _____

B. _____ _____

C. _____

D. _____ _____

_____

LIQUIDS

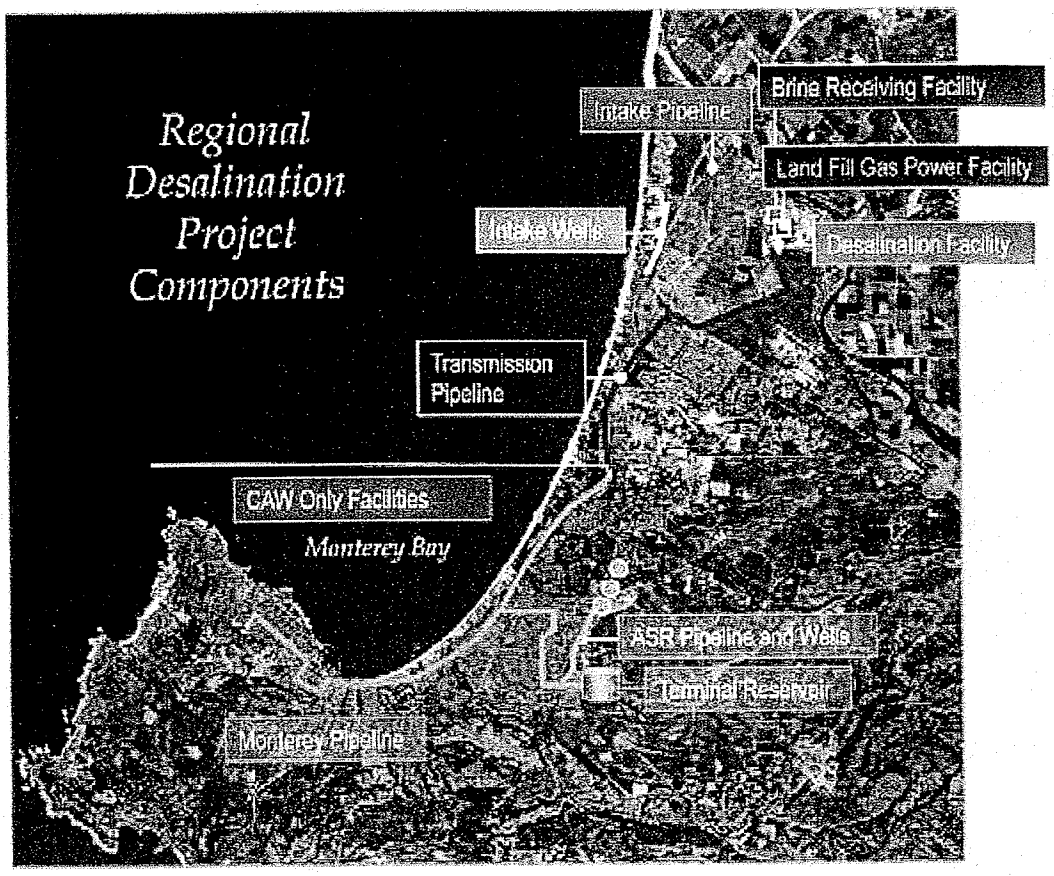
1. _____ Large materials are removed.
2. _____ Sludge is the heavy stuff that settles to the bottom of the tank. It is removed and sent to the Digester.
3. _____ Wastewater is cleaned by micro-organisms.
4. _____ Final settling of solids.
5. _____ Treated wastewater is sent over 1 mile out
or _____ to sea recycled on agricultural fields.

Regional Desalination Project

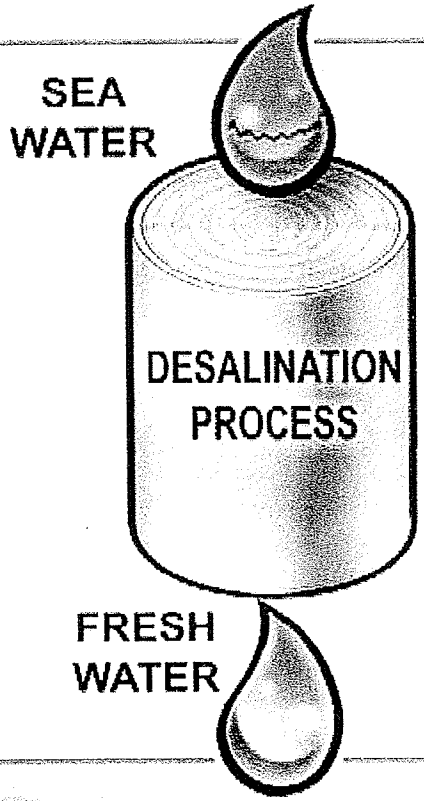
Many people are working together for a new water supply called the Regional Water Project. The main part of the project is a desalination plant. Seawater desalination is used in 120 countries around the world for drinking water.

What is "desalination?"

It means to take the salt out of ocean water, leaving only pure drinking water behind.



How does it work?



Wells will go deep into the sand near the ocean near Marina. Much of the salt and and sea life in this water has been naturally removed by passing through the sand. It is not yet clean enough to drink, but it is far closer to drinking water than if we pumped directly from the ocean.

Next, the salty water is pushed under great pressure through membrane filters. This works like a coffee pot: water molecules fit through the filter because they are small but coffee grains are bigger, so they stay behind the filter. Your family can drink the coffee, but you throw away the coffee grounds. Desalination is the same: the pure water molecules fit through the filter and become a new water supply. The concentrated salt (called brine) and other "stuff" gets left behind and is disposed safely away from any fresh water supply.

Like other water in our community, the water then passes through pipes and pumps and treatment plants, finally arriving at your home.

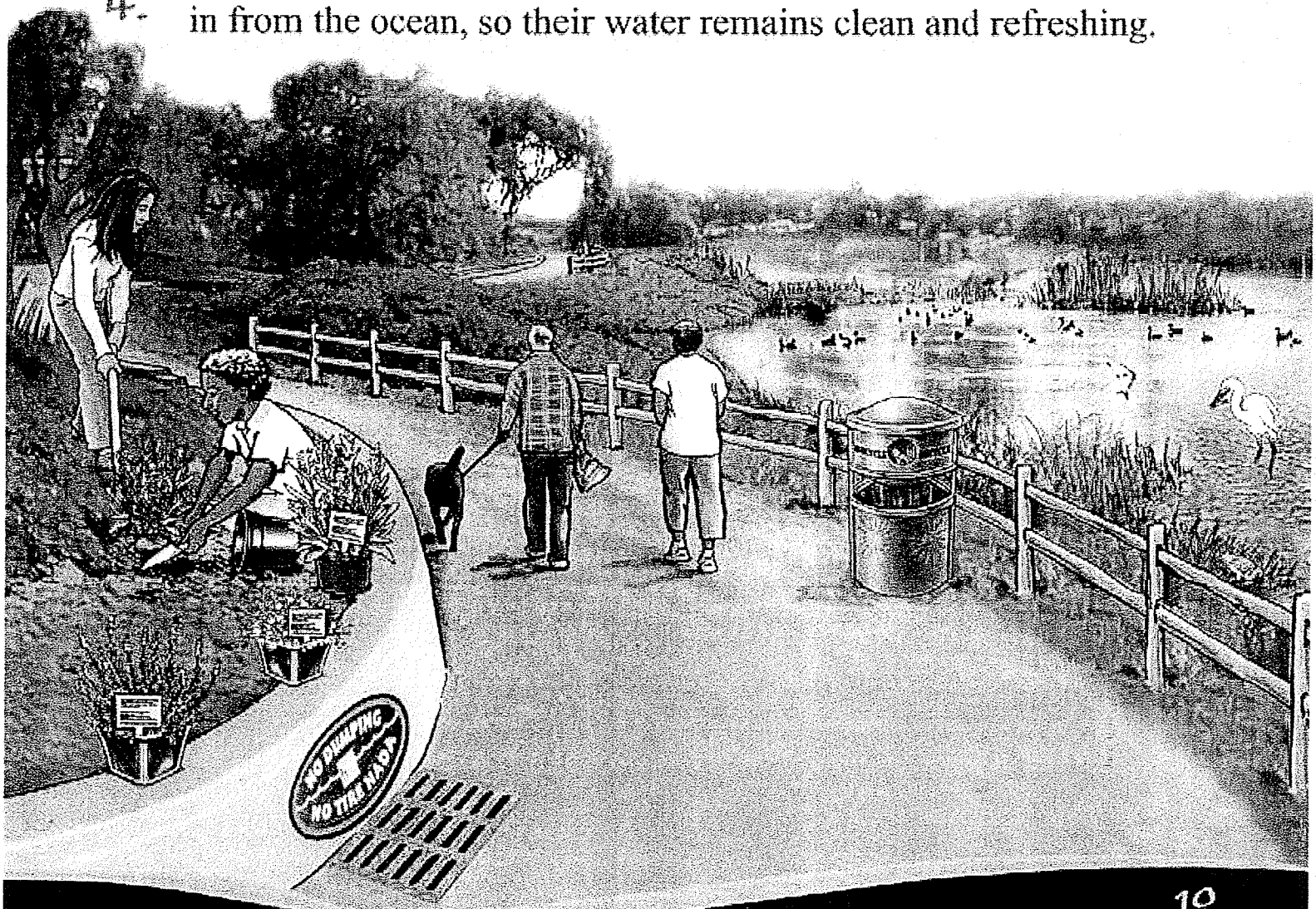
Why we need a new water supply for our region:

1. With a new water supply we will use less Carmel River water, especially in the summer. That will make life much easier for fish, frogs, and other river friends.

2. We can help nature refill the Seaside Groundwater Basin by reducing water pumped from it.

3. When there is little rain, we can still have enough water to meet the needs for people, plants and animals.

4. It will help our Marina neighbors push back salt water that is leaking in from the ocean, so their water remains clean and refreshing.



CALIFORNIA
AMERICAN WATER
www.californiaamwater.com

MONTEREY PENINSULA
WATER
MANAGEMENT DISTRICT
http://www.mpwmd.dst.ca.us
http://www.montereywaterinfo.org

A suggestion. There's room here for answers to the various quizzes, math problems, etc.

Water Pledge

This workbook is full of ideas to help you save water and protect our watershed.

What are ***you*** going to do?

I, _____
(your name)
pledge to conserve and protect our water by:

1. _____

_____

2. _____

_____

3. _____

_____

Printed on recycled paper. Recycling one ton of paper saves 7,000 gallons of water and 17 trees.

We thank the many Santa Cruz County water agencies, local governments, schools, teachers and students who created the "Our Water Works in Santa Cruz County" activity book for granting permission for us to use their great work. We have used much of their original work as the basis for this Monterey Peninsula version. The Santa Cruz County activity book credits author Vivian Gratton, illustrator Joal Morris, and designer Gwen Toevs who are likewise thanked by the consortium of Monterey Penisula water agencies and others shown here.