MUNICIPAL WATER DISTRICT OF ORANGE COUNTY

DISCOVERY SCIENCE CENTER

Fifth Grade ~ Teacher Packet

Themes: Water Preservation; Hazards of Water Pollution; Maximizing Water Sources

California State Science Standards addressed:

Earth Science

- Most of Earth's water is present as salt water in the oceans, which cover most of the Earth's surface.
- When liquid water evaporates, it turns into water vapor in the air and can reappear as a liquid when cooled or as a solid if cooled below the freezing point of water.
- Water vapor in the air moves from place to place and can form fog or clouds, which are tiny droplets of water or ice, and can fall to Earth as rain, sleet, snow or hail.
- The amount of freshwater located in rivers, lakes, underground sources, and glaciers is limited and its availability can be extended by recycling and decreasing the use of water.
- Know the origin of the water used by the local community.

Key Vocabulary:

Hydrological (water) cycle	Pollution	Desalination
Reclaimed water	Recycled wastewater	Filtration
Chlorine		

Key Concepts:

Point source pollution	Non-point source pollution	Contaminants
Transportation of water	Water purification	
Conservation	Available OC water supply	

Prompting and Closing Questions:

1. Describe the proportions and types of water located on Earth. (97% in the oceans, as saltwater; 2% in the glaciers as freshwater; 1% in other water sources, such as rivers, lakes and aquifers as freshwater.)

2. When liquid water evaporates, it doesn't disappear ~ what happens to it? (answers could vary, but should include that (a) the water molecules in the vapor form move father away from each other and (b) the water vapor condenses as the temperature drops to return to the liquid form or if it is cold enough, into the solid form.)

3. What three things are necessary to form a cloud? (water; particles in the air, such as dust, dirt, or ash; and a change in pressure / low pressure conditions.)

4. Besides the faucet and pipes, where does our water come from? (precipitation, groundwater/aquifers, aqueducts bringing water from Northern California and from the Colorado River.)

5. How do we reuse or recycle household wastewater? (used household / indoor water is collected in the sewer system, piped to a water treatment plant where it is highly purified, then pumped into a groundwater system or used to water outdoor areas, such as golf courses, parks, and the edges of freeways.)

The prompting and closing questions focus on the standards listed above and will be used by the program instructor during the visit to your school.

Background Information for the Teachers:

<u>Solids, Liquids and Gases ~ The 3 Forms of Matter</u>
There are three common forms of matter: solid, liquid and gas. The differences between these three forms depend on the motions and forces of the molecules or atoms of which they are composed.

- A solid has a definite shape and volume (i.e. a block of wood).
- Liquids have definite volumes and assume the shape of their containers (i.e. water in a cup).
- Gases expand to fill the volume and take the shape of their containers (i.e. oxygen).

The atoms of a solid material are very close together and although all of the atoms are moving, or vibrating, they are moving very slowly.

Not only does a liquid have a definite volume and assume the shape of its container, it is also free-flowing. In other words, we can pour a liquid and it all sticks together as a unit while we pour it. The atoms in a liquid are typically farther apart and vibrate faster than in the solid form, but these atoms still remain in contact with each other.

Since a gas has neither a definite shape nor volume, it expands indefinitely. Therefore, it needs a lot of space. The atoms of a gas spread out, passing and occasionally banging into each other.

If the temperature and/or pressure are adjusted, matter may undergo a phase transition. During a phase transition, matter shifts between these three forms. There are different ways matter can shift from one form to another: melting, freezing, evaporating, condensing, and subliming.

- Melting – changing from a solid to a liquid
- Freezing – changing from a liquid to a solid
- Evaporating – changing from a liquid to a gas
- Condensing – changing from a gas to a liquid
- Subliming – changing from a solid to a gas

Examples of these phase transitions:

- Melting – an ice cube melting
- Freezing – the opposite process of melting; freezing water into an ice cube
- Evaporating – steam rising from the surface of boiling water
- Condensing – moisture forming underneath the lid of a boiling pot
- Subliming – solid carbon dioxide (dry ice) changing into carbon dioxide gas

<u>Water Cycle</u>
Water is one of the only substances that can exist in three different forms (solid, liquid, gas) at the same point in time, under the same temperature and pressure conditions. For example, if you experience snow on a sunny day, you would see snow (solid water) slowly melting into liquid water because of the warming sunlight. This liquid water will then evaporate (forming gas water) due to the warming sunlight. As you breathe out, the water vapor (gas water) in your breath condenses into fog (liquid water).

We can see the same situation by carefully observing a glass of ice water. Ice (solid water) is floating in liquid water. Water vapor (gas water) from the surrounding air which is warmer than the glass of ice water, can condense onto the outside of the glass of ice water because the glass provides a cooler surface than the surrounding air ~ forcing the water vapor to change to a liquid water form (the droplets of water on the outside of the glass).

It is through this ease of water moving from one form into another that facilitates the water cycle. The water cycle is the course that water follows as it moves through the different phase transitions:

- The Sun causes liquid water to evaporate, turning the liquid water into water vapor (gas water).

- Hot air containing gas water rises. As it reaches the upper atmosphere, the air containing the gas water cools. This process condenses the gas water into liquid water, forming clouds.
- When clouds become heavily saturated with liquid water, the liquid water falls out of the sky. This process is called precipitation. Depending on the temperature, the precipitation can be in the form of solid water (snow) or liquid water (rain).
- When the liquid water reaches the earth's surface, it accumulates into puddles or pools. Snow accumulates in piles and eventually melts due to the warm sunlight.

Activity: The Rain Game

Materials:
- Assorted colored construction paper
- Tape
- Rope or other object to define a "puddle" area

Procedure:
In advance, tape assorted construction papers in a random pattern on the ground outside or in a large multi-purpose area. Tape as many pieces of paper as there are students. Have each of the students stand on a piece of construction paper with their arms outstretched from their sides. Explain that they each represent a drop of liquid water standing on a bit of dirt in the air. Together, they represent a small cloud.

When you say "go," have the students move from their piece of colored paper to another of the same color, keeping their arms outstretched. Each time one student touches another student, they need to grab hands to show that they are becoming a bigger drop of liquid water in the cloud. Together, they should keep moving to another piece of paper of the same color from which they started. If students of two different colors of paper join hands, they should to move to whichever of the two colors they represent that is the closest to them….this color will then become that group's color of paper.

Clusters of students (water drops) can also combine with other clusters of students (water drops). Once the cluster of water drops contains five students, they must go to the designated "puddle" area, defined by a rope or some other object. If the cluster contains six or more students, it must divide in half and each half must move to the next closest color to continue the game.

Continue with the game until the cloud all of the precipitation as occurred and the puddle is full.

Conclusion:
Explain that water vapor evaporates upward into the warm air. When the water vapor cools, it condenses onto the surface of a bit of dirt, ash, or other particle in the air. In the game, each paper represents a bit of dirt and each student represents a bit of water.

Water molecules and, therefore water drops, like to cling to one another. Within the cloud, the water drops will move around and begin to cling to one another forming bigger, heavier clusters of water. Once the water drops are too heavy to remain in the clouds, they will fall to the earth in the form of precipitation.

Background Information for the Teachers

Soils ~ Filtration and Percolation

Other processes related to the water cycle involve when the water comes in contact with the earth: (1) Runoff (2) Filtration and Percolation and (3) Underground Storage of water. Liquid water from many sources, including rain and melted snow, provide surface water and can run off to different areas. Streams, creeks, rivers, and even storm drains can deliver runoff water to the ocean, lakes, or manufactured reservoirs. This runoff water can be captured for our use in water storage systems, such as in reservoirs, or move quickly into the ocean where we cannot easily use it.

Other liquid water can soak into the ground through a process called percolation, if the soil is permeable and provides enough air spaces between the individual soil particles for the water to slip through. Typically, the larger the soil particles, the larger the spaces *between* the individual soil particles will be, and the more efficient the percolation process will be. An aquifer is an underground layer of porous rock and sand where water can accumulate for retrieval at a later date through a pumping system.

Filtration is a process related to percolation. As the water percolates through the soil, some materials can be filtered out of the water, helping purify the water as it moves toward storage in the aquifer. The water that is stored underground in the aquifers is called groundwater.

Activity: Aquifers ~ Groundwater and Percolation

Materials:

- Four chairs or other objects to define an “aquifer” area
- Blue pieces of construction paper

Procedure:

Set up four chairs or other objects to define an “aquifer” area. Place ¾ of your students in the middle of the defined area / aquifer, facing different directions, with their arms outstretched and their fingertips touching the fingertips of the next closest student. Explain that in this position, they will represent gravel or large rocks.

Have the remaining students each hold a piece of blue construction paper to represent that they are water flowing from one side of the area, through the gravel-filled aquifer, to the other side of the area. Once they make it to the other side of the area without moving any of the “gravel” out of place, they are “safe” in a groundwater basin. In order to get them out of the groundwater basin, the “water” students (now representing

“groundwater”) would have to be pumped back out of the groundwater basin, through the aquifer, to the surface from where they started.

Explain that the process of the surface water moving downward through the gravel-filled aquifer, toward the groundwater basin, is called “percolation.” Gravity and the fact that there is space between the pieces of gravel make percolation possible.

Sometimes, the aquifer is made of sand, instead of gravel and the water moves (percolates) past the smaller particles. To model this, have the “gravel” students move closer to one another, facing different directions, and put their hands on their hips, touching elbows with the other students. They are now representing “sand.” Have the “water” students try to move through the sand-filled aquifer, like they did with the gravel-filled aquifer, to get to the groundwater basin. Point out to the students that the percolation process through sand is much slower than through gravel ~ but that the water was still able to get through the aquifer into the groundwater basin.

Lastly, have the “sand” students model what would happen if the defined area was full of clay. Because pieces of clay are very small and close together, have the “clay” students stand close together, facing different directions, hands down, shoulder-to-shoulder. Notice now that there are no spaces for the “water” students to travel past. In fact, this area is no longer an aquifer, since it does not allow for percolation to occur.

Conclusion:
Aquifers only occur in gravel or sand-filled areas. Those areas that do not have gravel or sand-filled areas, do not contain groundwater basins. If an area does not have a groundwater basin, the surface water runs off and cannot later be retrieved.

Activity: Filtration ~ Desalination and Purification of Water

Materials:

- New panty hose, cut to include the foot and 18 inches of the leg
- Water
- Dry rice or sand representing salt or other impurities
- Pitcher
- Bowl

Procedure:
Explain that scientists use filtration methods to purify water and in some cases, even take the salt out of ocean water. To demonstrate how some pollution or salt can be filtered out of the water, take a pitcher and fill it most of the way full with water. Add dry rice, sand, or other material to represent salt or other impurity in the water. Hold the cut-off panty hose over a bowl, then pour the ocean water/ polluted water through the leg of the panty hose. This demonstrates filtration ~ how the objects will get caught inside the hose, but allow the mostly clean water to drip through.

Conclusion:
Scientists now have special filtering hoses that have such small holes and the water is pushed through these holes with such great force, that they are actually able to remove most forms of pollution ~ including bacteria and some viruses. They use a similar method to take the salt out of ocean water. The process of taking salt out of ocean water is called desalination.

Activity: California Map and Our Aqueducts

Materials:
- California map handout

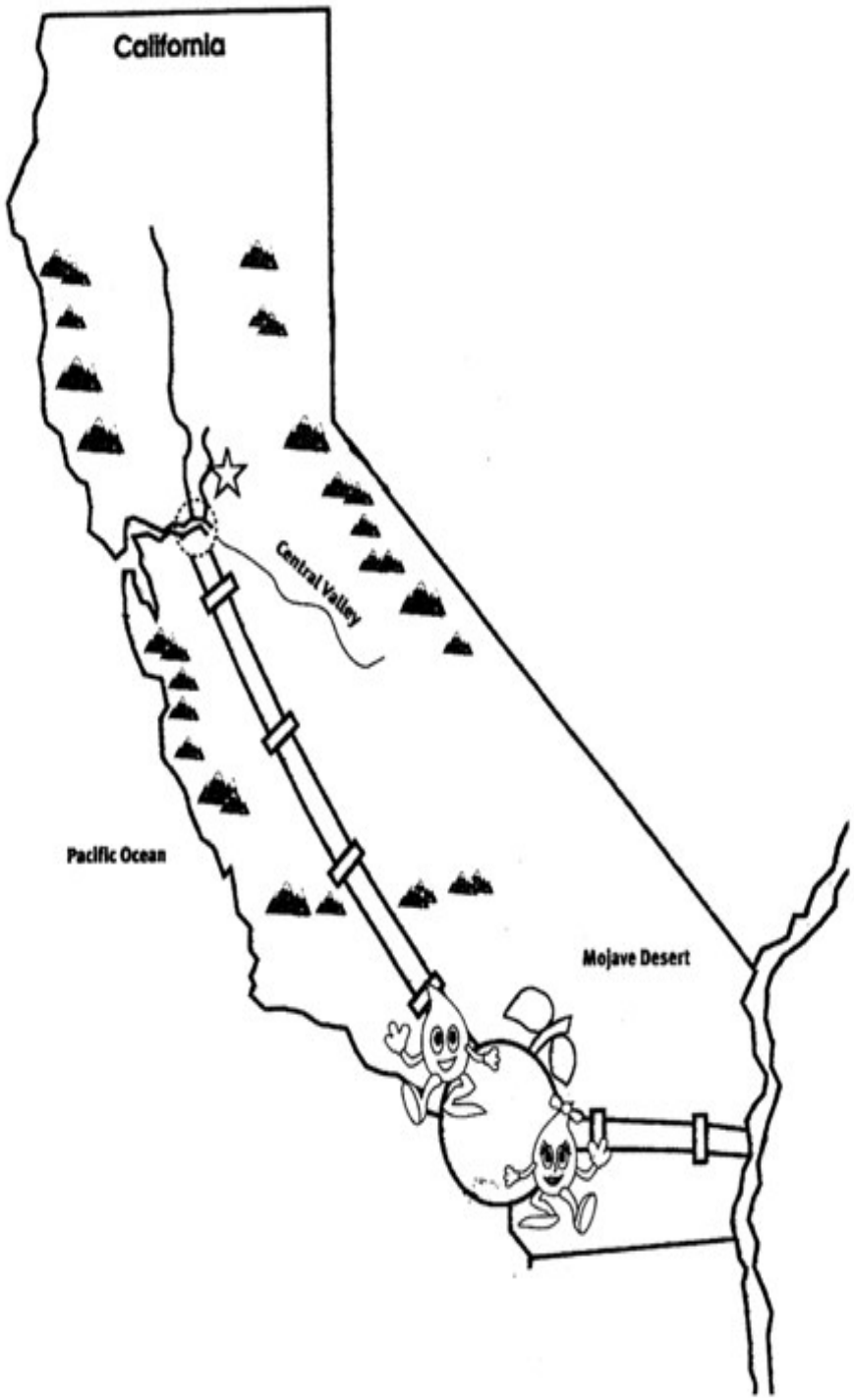
Procedure:
Distribute copies of the Map of California to the students. Have them follow the instructions, including coloring and labeling the different objects and locations. If you have a California map in your classroom, use that to help emphasize some of the locations.

Conclusion:
Because Southern California has a natural scarcity of water, and some of our cities do not have groundwater basins, it is necessary to get our water from other areas through aqueducts.

Conservation of Resources Activities:
A copy of the "Water Cycle" and "Water, Who Needs It?" video and accompanying posters may be obtained from the Department of Water Resources for free at www.publicaffairs.water.ca.gov/education/orderform.cfm

Resources, such as water, are used in everyday life.
Have the students create a list of some of the water sources in and around the school. Take a short walk around the school grounds if possible to look for more ideas (sprinklers, drinking fountains, sinks and toilets, water cooler or coffee pot in the teachers' lounge, fire hydrant, hoses, etc). Discuss the uses of each type of water source and whether it is necessary. In fact, you should discover that all of the water sources are necessary. While taking your walking tour, pinpoint ideas about how water can be used wisely or can be wasted; for example, hoses supply water to plants, but over-watering plants can lead to wasted water.

Check for leaky faucets or fountains during your walking tour, or areas where water may have pooled or the ground is muddy due to over-watering. If you discover these areas, discuss with the students a strategy for correcting this wastefulness. Perhaps the students can create a poster or campaign-type letter to encourage saving water; these can be passed along to the principal or maintenance crew or even taken home to the students' parents. Have the students conduct a similar walking tour at home with their parents in order to have the students encourage their parents to help conserve water.


California
Central Valley
Pacific Ocean
Mojave Desert

DISCOVERY SCIENCE CENTER

Map of California

MUNICIPAL WATER DISTRICT OF ORANGE COUNTY

Instructions:

11. Color the orange orange. This is where Orange County is. Label Orange County.

12. Label the map to show North, South, West, and East.

13. Color the short pipe that runs east to west, purple. This is where the Colorado River Aqueduct brings water to us. Label the Colorado River Aqueduct.

14. Color the squiggly line running north to south on the bottom rightside of the map blue. This is a part of the Colorado River that supplies the Aqueduct with water. Label the Colorado River.

15. Color the long pipe that runs north to south, red. This is where the California Aqueduct brings water to us. Label the California Aqueduct.

16. Color the mountains on the eastern side of California gray. These are the Sierra Nevada Mountains that receive a lot of rain and snow. Label the Sierra Nevada Mountains and draw arrows showing how the water flows westward into the Central Valley.

17. Color the mountains on the western side of California brown. These are the Coast Ranges. Label the Coast Ranges and draw arrows showing how the water flows westward into the Pacific Ocean.

18. Color the dotted circle green. This is where water is captured in the San Francisco Bay Delta before it flows into the Pacific Ocean. Label the Delta. This water supplies the Califonia Aqueduct with water.

19. Color the star yellow. This is where our state capital, Sacramento, is.

20. Put an X on the Mojave Desert.